The Dissertation Committee for Christian Rene Youker certifies that this is the approved version of the following dissertation:

Teachers' Perspectives of Why and How They Use the Resources of Informal Science Education Sites

Committee:

James P. Barufaldi, Supervisor

Marilyn L. Fowler

Judith B. Harris

Anthony J. Petrosino

Angela Calabrese Barton

Teachers' Perspectives of Why and How They Use the Resources of Informal Science Education Sites

by

Christian Rene Youker, B.A., M.S.

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Dedication

This dissertation is dedicated to the six wonderful teachers who participated in this study. Their passion for science and science teaching was inspiring.

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Teachers' Perspectives of Why and How They Use the Resources of Informal Science Education Sites

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Supervisor: James P. Barufaldi

There has been a growing interest in fostering increased connections between schools and community resources – such as informal science sites. This is due, in part, to the recognition that museum learning has many potential advantages, including improving motivation and attitudes, and nurturing curiosity. Some teachers are using the resources of informal science sites more than others. The purpose of this study was to determine why and how some teachers have continually used the resources of informal science education sites. The study was situated within a constructivist paradigm and employed a naturalistic inquiry strategy. Emergent interviews were conducted with six elementary teachers who regularly used the resources of informal science sites. Observations of informal science use and relevant documents were also used in data analysis. Using a qualitative data analysis program, data were unitized, coded and emergent themes

were identified. Findings indicated that the teachers shared many characteristics in terms of *why* they used informal science, and they situated this within the context of their approaches to science teaching. Yet they valued different aspects of informal science as a resource. Support, especially emotional and social support, for using informal science was also important to these teachers, although where this support came from differed among them. All of the teachers had a strong interest in science, were leaders in science education on many levels and tended to seek out science-related projects and activities. While they shared many characteristics in terms of their approach to science teaching, there was great variation in how these teachers used informal science sites and in the amount and kind of support they received. These findings support the notion that there may be many definitions of the effective use of informal science by elementary teachers.

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Chapter One: Introduction

As I finish my last interview with Betty, a fifth grade teacher at Westside Elementary, an urban school in a high poverty area, I wonder how I ever remained interested in science when I never had a teacher like her. In elementary school, we never did science. We read about it, but we never actually *did* it. We never walked to a nearby creek and investigated the creatures that lived in the mud. We never learned the life cycles of mud puppies by watching them grow and change in front of our eyes. We never took our rescued iguanas to the younger children at school and taught them how to care for them. And we certainly never regularly visited the local nature center to conduct a long-term study of the pond. What drives Betty to *do* science with her students? What makes her seek the resources and programs of local museums and nature centers?

Most teachers are not like Betty. For whatever reason, whether due to an uneasiness with science, a lack of support from their principals, or simply an unfamiliarity with science education resources, many teachers do not take advantage of the unique resources that informal science sites* have to offer. A 1995 survey of informal science education sites found that there is approximately one informal science site for every 1,000 elementary school teachers in the United States. Yet, these institutions serve only 10 percent of all U.S. teachers (Inverness Research Associates, 1995). Many students may be missing out on some very

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* The terms *informal science site* and *museum* are used interchangeably throughout this study. They refer to any site offering informal science learning opportunities, i.e. zoos, museums, parks, nature centers, aquaria.

valuable learning experiences. Museum learning has many potential advantages, including: improving motivation and attitudes, engagement in the subject through participation, and nurturing curiosity (Ramey-Gassert, Walberg and Walberg, 1994). All of this can lead to an enhanced desire to learn. Those teachers, like Betty, who regularly use museums in their teaching have students who are likely *doing* science – and, even more importantly, are enjoying it. The intent of this study is to understand something about why and how they use informal science in their teaching in order to inform this issue of connecting more teachers with museums.

RATIONALE

Science teaching and learning can no longer be confined to the classroom. The National Science Education Standards states, "the school science program must extend beyond the walls of the school to include the resources of the community" (National Research Council, 1996). When most teachers are not taking advantage of the resources of the informal science community, knowing more about those who do can inform those interested in connecting teachers with museums. Interestingly, research that reveals the perspectives of these teachers who are repeatedly using informal science resources appears to be a largely unexplored area. The museum education literature has tended to focus on the learning experiences of individual and family visitors while they are in the museum (e.g., Bitgood, Serrell and Thompson, 1994; Duckworth, 1990; Falk and Dierking, 1992; Hein, 1998; Hein and Alexander, 1999) and the literature on museum-school partnerships has mostly been done from institutional perspectives where the emphasis is on forming formal partnerships (e.g., Hirzy, 1996; Russell, 1996, 1997; Sheppard, 1993; The Franklin Institute Science Museum, 1992). There are descriptive examples of successful museum-school partnerships (e.g., Hirzy, 1996; The Franklin Institute Science Museum, 1992), but these do not focus on the perspectives of the people involved. They instead emphasize the museum-school partnership itself and the programs produced – on an institutional level.

In addition, the few studies that focus specifically on teachers and informal science are either quantitative where the teachers' voices are absent (Lessow, 1990) or address the perspectives of students, informal educators *and* teachers so that the focus is not solely on teachers (Mullins, 1998). Perhaps more importantly, the literature on this topic is focused on the field trip only and not the teacher who uses informal science sites in unique ways. I believe that focusing on the *teacher*, and not solely the *practice* of using informal science is valuable in understanding and addressing the topic of teacher use of informal science. As Goodson (1992) explains in his chapter, "Sponsoring the Teacher's Voice: Teachers' Lives and Teacher Development", focusing on teacher practice alone cannot possibly capture what is needed to ultimately seek reflection and change in teacher practice. When teachers talk about issues related to their practice, they constantly include information on their own lives. Goodson (1992) states that this is evidence that teachers themselves consider this to be of major importance. These personal life issues need to be considered and reflected upon.

In this study, I have chosen to focus specifically on elementary teachers who use informal science on a regular basis in their science teaching. And I emphasize their voices using a constructivist approach in my research design. These teachers are known to be strong science teachers at the elementary level and use informal science often for more than a one-time field trip. Knowing what motivates these teachers to use informal science in the ways that they do requires more than understanding institutional issues and requires focusing on more than their perspectives on specific field trips, but on them as people. Readers hearing these stories and seeing themselves or others they know reflected in these teachers' words can hopefully help cultivate more successful relationships between museum and schools. In addition, by understanding why these teachers use informal science, we can better understand why others do not.

FOCUS QUESTION

The focus question for this study is "Why and how do teachers continually use the resources of informal science education sites?" I chose to look at the perspectives of teachers because I believe they are truly the agents of change. Teachers are the ones who ultimately decide if they will use informal science in their teaching and they are personally able to see any benefits for their students. I was curious as to the reasons for their use of informal science, how they use it, and how they are able to use it.

CONTEXT

This study focuses on six elementary school teachers in and around an urban area in Texas, which includes three separate school districts. The teachers range from kindergarten level to fifth and sixth grade level. Two of the teachers teach in high-poverty areas, while the rest teach in moderate to high-income areas. They are all known by others to be exceptional science teachers who use, or have used, informal science extensively in their teaching. The study focuses mainly on interviews and observations of these teachers which took place over a six-month period.

The area could be considered relatively rich in informal science resources. There is a long-established Nature Center, a Children's Museum – recently housed in a newly renovated warehouse building downtown, a Museum of Science and History – located at the university, a nationally recognized Wildflower Center, and multiple local parks and university resources. In addition, there is an annual Science Fun Day hosted by the Museum of Science and History in which teachers partner with local businesses or informal science sites and set up project booths for the public to enjoy. It is a largely progressive, technology-rich area with many science opportunities for teachers to explore.

SUMMARY

This dissertation has six chapters. Chapter One is an introduction and provides the rationale for the study, focus question and general context. Chapter Two is a review of the literature pertaining to the connections between informal science sites and schools, teachers' use of informal science, the notion of "effective science teaching" and teachers' attitudes towards science. Chapter Three is a description of the methodology used for this study, which was based upon a constructivist paradigm and employed naturalistic inquiry as the strategy.

Chapter Four is a description of the findings in a case-by-case format, in which each teacher is described separately. Chapter Five is also a description of the findings, but in a cross-case format where the major emergent themes are highlighted. Chapter Six is a discussion of the findings as they relate to the literature and includes my interpretations of the findings, as well.

Chapter Two: Literature Review

In order to describe the theoretical underpinnings of my research, I will first review the literature on the benefits of forming connections between informal science sites and schools, the changing role of informal science in education and teacher use of museums. Secondly, because the teachers involved in this study were known to be "good teachers", have a strong interest in science and be involved in informal science projects as it related to their teaching, I will briefly discuss the literature surrounding the notion of the "good teacher" or the "effective teacher" as it relates to elementary science teaching.

CONNECTIONS BETWEEN INFORMAL SCIENCE SITES AND SCHOOLS

Recently, there has been a growing interest in fostering relationships between informal science sites and schools among both school and informal educators. This is due, in part, to the recognition that informal education sites have the potential to offer more than a one-time field trip to teachers and students. According to Ramey-Gassert, Walberg and Walberg (1994), museum learning has many potential advantages, including: improving motivation and attitudes, engagement in the subject through participation, and nurturing curiosity. All of this can lead to an enhanced desire to learn. This in itself may be reason enough for educators to be interested in fostering connections between schools and museums. Wellington (1990) found that the atmosphere of informal science learning, which included features such as "voluntary, unstructured, non-assessed, open-ended, and learner-centered" (p. 248) led to increased student interest and learning. And this open-ended learning experience can also have positive effects on how students feel about science learning. (Gottfried, 1980; Lebeau, Gyamfi, Wizevich and Koster, 2001). While the most beneficial aspect of informal science learning may be the often immeasurable notions of appreciation and motivation for continued learning, researchers have also reported gains in science content knowledge by students (Gottfried, 1980; Klevins, 1990; Stronck, 1983; Wright, 1980).

Most importantly, however, museums can offer teachers and students that which they often cannot truly experience in the formal classroom – informal learning. Hein and Alexander (1998) describe the experience this way:

> Perhaps it is precisely *because* museums are informal learning settings, where attendance is voluntary and meaning not prescribed, that they are so loved. In a museum, the visitor may wander at will, lingering here, breezing through there, taking in those things that connect to prior knowledge and experience, and discovering new ideas with delight (p.42).

In *First Hand Learning: Teacher Education in Science Museums (1990),* Inverness Research Associates conducted case studies of nine science museums that were involved in teacher education. They found that all of these museums, however different, all had a common philosophy of education – an experiential approach to learning and teaching. This research also found that science museums could be particularly good at supporting individual teachers in two ways. First, they can provide an informal atmosphere that allows teachers to relax and have fun in their own learning. Second, the museum experience can re-kindle their commitment to the learning process of discovery and inquiry. When in partnership with a school district or university teacher education program, this may have a meaningful impact on a teacher's overall approach to teaching.

While some museums still present the traditional image of a "hands-off" exhibit hall where there is little opportunity for open-ended science explorations, many have been utilizing a hands-on experiential learning approach for decades. In contrast, many classrooms still practice more traditional approaches (Resnick, 1987). Resnick, in her AERA 1987 Presidential Address *Learning In School and Out,* elaborates on this difference, stating that classroom learning has tended to be solitary and divorced from real-world experiences, with little or no connection to the events presented. And even when 55% of teachers reported that their students engage in hands on activities at least once a week (National Center for Education Statistics, 2000), it is likely that many of those activities are not inquiry-based. Kluger-Bell (1999) states that, "Inquiry is being used to describe a vast array of science-teaching strategies. All of these strategies can be valuable when used at the right place at the right time. But are they all inquiry?" (p. 39). In contrast, out-of-school learning often involves the accomplishment of an intellectual task by a group that is interacting using real materials, which allows learning to take on greater meaning (Resnick, 1987). Like schools, museums are likely to be disguising hands-on activities as inquiry-based activities, but they are also a "natural setting for inquiry" (Middlebrooks, 1999). With knowledgeable teachers and museum educators working together, informal science sites have the potential to contribute greatly to a student's overall educational experience.

However, before educators aim to make schools more like museums, it is important to realize the inherent differences between schools and museums. Even when students in school classrooms are doing a similar activity as students in an informal environment, there are important differences between the assumptions that are made as the teaching/learning is taking place. According to Falk (2001), informal learning stands apart from school learning in that it is free-choice, non-sequential, self-paced, and voluntary. The formal education system was not designed in this way. Schools are designed to educate students so that they are prepared to function successfully in society. The learning requirements are set as standards that all students are expected to learn. The teaching and learning that therefore most often occurs in schools involves compulsory learning in which learning is driven by a predetermined set of requirements imposed externally by an imposed authority (Falk, 2001). And yet, both approaches are important components to learning. Unfortunately, as Falk and Dierking (1992) point out, learning has become synonymous with the words "education" and "school" where learning is viewed as "primarily the acquisition of new ideas, facts, or information, rather than the consolidation and slow, incremental growth of existing ideas and information" (p. 98). Recognizing these differences is important to understanding how each approach and their associated underlying assumptions are part of the total learning experience of students and teachers. Rather than trying to make one institution more like the other, a better approach may be to recognize the strengths of both museums and schools and to bring those resources together to better serve both teachers and students.

As Tressel (2001) points out, the informal and formal education communities are pursuing the same goal of educating the public – even if it stems from different assumptions and inherent qualities. Each has its own unique strengths. One way that museums can contribute to this goal is by helping teachers to gain confidence in teaching science. Science teaching confidence, or science teaching self-efficacy, is an important component of effective science teaching. Teacher efficacy has been found to be one of the most significant factors influencing teachers' work (Ashton an Webb, 1986; Smylie, 1990) and is an important factor in teacher motivation (Ashton and Webb, 1986). Inverness Research Associates (1990) reported that long-term association with a museum can begin to shift a teacher's confidence in science teaching. For example, one teacher in their study reports, "This museum has done a lot for the individual teacher. I think many of us have undergone a long-term change in our teaching style, and are more confident and comfortable in a student-centered teaching approach" (p.16). Price and Hein (1991) also reported gains in science confidence and enthusiasm by elementary school teachers after they were involved in collaborative projects with a science museum. And according to a recent national survey, only approximately 25 percent of elementary teachers feel they are well qualified to teach science (Horizon Research, 2001a). Furthermore, teachers will generally avoid situations where they doubt their ability to perform successfully (Ashton and Webb, 1986). Improving elementary teachers' science teaching confidence is therefore an important factor in improving science education.

Research has also shown that in collaboration with individual schools and universities, informal environments have the potential to help prepare in-service and pre-service teachers to teach science. In general, elementary teachers feel apprehensive about teaching science (Schoeneberger and Russell, 1986; Tilgner, 1990) and for pre-service elementary teachers, the thought of teaching science can make many of them uncomfortable (Pederson and McCurdy, 1992). The relaxed and user-friendly nature of many museums may help them to feel more at ease with the task of teaching and learning about science. Martinello and Gonzalez (1987) studied a collaborative effort between a university and local museums in which pre-service teachers were being prepared to teach science. They found that informal learning environments improved the teachers' attitudes towards science and provided them with unique insights into children's ways of understanding and learning about the natural world. In support of this, Kelly (2000) describes the benefits of including informal science education in an elementary science methods course where the emphasis is on constructivist-based teaching and learning. In addition to time spent in the classroom, the student teachers were able to work alongside elementary students in inquiry-based science explorations at an interactive informal science center. Over 90% reported significant gains in their perceived understanding of science and in their ability to teach science. Kelly (2000) asserts that informal science sites can be ideal environments for allowing future teachers to experience both teaching *and* learning so that they may better serve their students. The *informal* or *free-choice* nature of informal learning environments was also found to be of great value. One student claimed that, "Doing science in a non-structured environment made me decide to set up a small space in my classroom where students can do science on their own" (p. 768).

Due to this recognition of the benefits of informal science learning, an increasing number of universities are partnering with informal science sites in preparing their future teachers. Middlebrooks (1999) describes the many benefits that preservice teachers receive, including the opportunity to work with children of different ages and backgrounds, the opportunity to work with other educators, the opportunity to practice good science teaching and gain confidence, and the knowledge of science teaching resources. In her book, *Preparing Tomorrow's Teachers: Preservice Partnerships Between Science Museums and Colleges*, Middlebrooks (1999) highlights 12 different partnerships to serve as models for others seeking to create similar projects. Across all of these partnerships, the specific strengths of the informal sites are recognized and brought into the training of future teachers. One education professor described the particular advantages of using the resources of an informal science center.

> I could build a cave at the college or in a school classroom, but my preservice students wouldn't loosen up because they would feel threatened thinking they have to know everything; and the elementary students wouldn't loosen up because of their previous school experience. In many elementary classrooms, kids sit in rows and even when they work in groups, teachers control and run the classroom. In contrast, the museum is a natural setting for inquiry where kids are encouraged to work independently once we get them started. Moreover, museums have the resources of exhibits and collections that classrooms can't even begin to imagine. (Middlebrooks, 1999, p. 31).

As suggested by the university professor above, in addition to the benefits of a unique kind of teaching and learning that occurs in informal environments, research also suggests teachers can benefit from the resources and programs offered by museums. This can include interactive exhibits, educational materials and science equipment that many teachers and school districts cannot afford or do not have access to in school (Russell, 1996). Ramey-Gassert (1997) stresses the value of using relevant, realistic museum materials and settings in helping teachers to engage hard-to-reach students. And as Falk, Koran, and Dierking (1986) point out, the "things" of science museums are what often makes them unique. While most museums do not go beyond providing guided tours and opportunities to encounter real-life objects and experiences, based on the surveys reports by Inverness Research Associates (1990) and Hirzy (1996) other forms of support for teachers include:

- The development, maintenance, and delivery of science kits
- Special outreach efforts that bring short lessons, or demonstrations to teachers' classrooms
- Pre-visit lessons to prepare students for a museum trip and build links with the school curriculum
- Longer term, in-classroom assistance and collaboration with museum staff including special projects and teaching workshops

Unfortunately, many museums have tended to focus their energies on short-term services, due to the lack of underlying structure to support long-term collaborations (Munley, 1991; Russell, 1997). Yet, with the recent increased interest in informal science from the education community, this is likely to change.

While the results of this research concerning teachers and museums is not surprising, I believe the fact that more research in this area of informal/formal relationships is emerging is significant; and it reflects the changing role of informal science. Museums are no longer simply interesting places to visit where little connection is made to the classroom; many of them are interested in establishing long-term relationships with teachers. Museums have long provided schools with services such as field trips, demonstrations, or loan kits. As Russell (1996) points out,

> In the past, science museums offered field trip programs, teacher workshops, and other services as products which would enrich, but were not an integral part of the school curriculum. Museum programs were there for the taking, without explicit links to the school curriculum (p. 8).

Field trips have primarily been one-time events where little connection was made to what was happening in schools. While these types of services are still an important part of museum education, and have by no means disappeared, an increasing emphasis has been placed on more long-term relationships with schools. This was clearly shown in a survey by Inverness Research Associates (1995) where two-thirds of informal science institutions were engaged in educational collaboratives or partnerships, and half of all institutions offered teacher workshops, provided classroom support and assistance with materials, and helped schools with curriculum development. This study also found that museum educational programs in general have grown substantially during the last 10 years. In 1995, 45% of respondents agreed that the scale of school-related programs was likely to "increase dramatically" in the next three years (Inverness Research Associates, 1995). And in a 1996 survey of museums, 70 percent reported an increase in the numbers of students, teachers and schools served over the last 5 years. The survey results also indicated a trend towards increased K-12 educational programming and correlation to school curricula over the last 5 years (Hirzy, 1996). In addition, this same study reported that museum staff felt that *teachers* were the key to forming educational partnerships. Teachers most strongly influence the decision by schools of whether to work collaboratively with museums (Hirzy, 1996).

Informal science has stepped up to a larger role in science education in the last few years. For example, there is now an Informal Science Education Advisory Board with the National Science Teachers' Association (National Science Teachers' Association, 1996) and informal science education is now a board affiliate of the Science Teachers' Association of Texas (Science Teachers' Association of Texas, n.d.). The National Science Teachers' Association's position statement on informal science education states that, "NSTA recognizes and encourages the development of sustained links between the informal institutions and schools……..NSTA strongly supports and advocates informal science education because we share a common mission and vision articulated by the National Science Education Standards….." (NSTA Informal Science Advisory Board, 1998, p. 30). The National Science Foundation has also focused on informal science and initiated an educational research grant program in informal science education (National Science Foundation, 1999b).

Further, more museums and other informal sites are collaborating on educational projects linking with formal education. For example, in a 1996 grant funded by the National Science Foundation and Unisys Corporation, an online community of educators, students, schools and science museums was formed in order to demonstrate a new model for inquiry science education (Science Learning Network, n.d.). The Museum Learning Collaborative (n.d.) is another example of the informal community working together to make a difference in education. It is a five-year national study with the purpose of increasing understanding of the nature of learning in museums. Finding effective ways for working with schools in educating students is an important part of this project. And in 2001, building on the recent interest in informal science centers, an $11 million grant from the National Science Foundation was awarded to fund a new international center to improve science education – the Center for Informal Learning and Schools (Exploratorium, 2001). The Exploratorium in San Francisco is collaborating with King's College London and the University of California, Santa Cruz to better understand how children learn in informal settings and how these techniques can be adapted to a school setting.

Individual teachers are also taking notice. A 1999 issue of *Science Activities: Classroom Projects and Curriculum Ideas* is devoted entirely to linking formal and informal education. In the editorial for this issue, the authors point to the increasing awareness that visits to informal learning institutions are more than annual outings (Melber and Abraham, 1999). They further emphasize that teachers and informal learning institutions must be aware of the resources each can provide the other so that future partnerships can be promoted. And in 2001, the National Science Teachers Association published two book volumes devoted to the connections between informal science sites and schools entitled *Community Connections for Science Education* – Volume 1: *Building Successful Partnerships* (Robertson, 2001) and Volume 2: *History and Theory You Can Use* (Katz, 2001). These were specifically aimed at both formal school teachers and informal educators where the emphasis is on both practical advice and real-life examples of successful collaborations. No longer is informal learning defined simply as the kind of learning that takes place outside of the classroom. The formal and informal education communities ultimately have the same goal. As Tressel (2001) states in Volume 2: *History and Theory You Can Use*:

> Education and learning are a *system.* The successful students reflect a combination of innate talent, outside environment, and the classroom opportunity. Both formal and informal education systems pursue an integrated goal. They build and reinforce a schema of knowledge ….. They work to develop enthusiasm… Schools cannot do this alone. They need the enthusiasm and reinforcement of students who are *already prepared to learn* at every level (pp. 1-2).

Many educators, from both the formal and informal sector, have recently realized the potential value in making more lasting connections with each other. Informal learning institutions can work with teachers in a variety of ways, and the diversity of resources offered reflects this. There are therefore many reasons why a teacher may be drawn to an informal institution. It could be the nature of the interactive exhibits, the loan kits, or simply the relaxed, open-ended approach to learning found in many museums. Many institutions have been striving to meet the needs of teachers so that more teachers are likely to return. I believe that in many cases, it may come down to how well a museum provides opportunities for teachers to feel comfortable and confident in their ability to teach science.

Teachers may visit an informal site once a year with their students simply because of the interesting exhibits, but they are unlikely to return if they see no other possible benefits for themselves or their students. Many informal institutions are becoming more focused on creating more opportunities for working with teachers, and this means providing a variety of resources and a level of comfort for them. Yet most museums and teachers are still not forming these educational relationships.

WHY AREN'T MORE TEACHERS USING INFORMAL SCIENCE?

In planning for a small-scale pilot study for this research (Youker, 1999), I asked one museum educator for the names of teachers who used her museum frequently and with whom the staff had some sort of relationship. She could name only four teachers total; and yet, they have thousands of students and hundreds of teachers come through their museum yearly. Inverness Research Associates (1995) found that there is approximately one informal science education institution for every 1,000 elementary school teachers in the United States. Yet these institutions serve only 10 percent of all U.S. teachers teaching science. Do most teachers still perceive museums as simple, one-time field trips with little or no links to their curriculum? Why aren't they utilizing the resources that informal science sites have to offer?

While there has indeed been a shifting focus to increase the numbers of these relationships with teachers, many teachers do not seem to be using museum resources in "partnering" ways where explicit links are made to classroom curricula and teachers return for additional assistance and collaboration as needed throughout the school year. If informal science may benefit the formal science education of students, then why aren't more teachers using museums and other informal science sites?

The literature on this subject is centered around the assumption that "using informal science" actually refers to "taking field trips". And the phrase, "taking field trips" is the one used most often. These studies therefore do not directly address those teachers who continually use informal science sites *in many different ways.* Nevertheless, these studies reveal why teachers may not be as likely to take their students on field trips as other teachers. Common explanations for why teachers are not taking field trips can be grouped into several categories.

- *Logistics*: transportation coordination and cost (Kaspar, 1998; Lessow, 1990; Michie, 1998; Price and Hein, 1991), safety concerns (Michie, 1998); and possible student misbehavior and large class size (Fido and Gayford, 1982; Lessow, 1990; Price and Hein, 1991)
- *External Support System:* a lack of support from administration who see the field trip as a "vacation" (Michie, 1998; Mullins, 1998; Price and Hein, 1991); and a lack of support from other teachers who are uncomfortable with new experiences and getting out of the classroom (Michie, 1998; Mullins, 1998)
- *Personal Motivation:* such as fear of failure (Mullins, 1998), lack of energy and time (Lessow, 1990; Michie, 1998; Mullins, 1998; Price and Hein, 1991) low interest (Mullins, 1998); and lack of personal knowledge

of and positive experiences with informal science sites (Fido and Gayford, 1982; Michie, 1998)

- *Availability of Resources:* inadequate choice of informal science sites (Michie, 1998)

The above literature addresses why teachers are not taking field trips. To take this a step further, why are teachers not working with museums in more “collaborative ways” where there is a longer-term relationship and teachers are using the many resources of museums? The literature in linking museums and schools tends to be focused on forming partnerships on an institutional level, and does not focus on the teachers themselves. Russell (1996) points out that many of the difficulties involved in linking informal science institutions and the formal education system can be attributed to differences in size, orientation, and mission. School systems are public organizations much larger than museums with corresponding larger bureaucracies, and tend to be resistant to change. Museums tend to be smaller than school systems, are market driven and are mostly private. Russell (1996) asserts that these obvious differences can make connections very difficult to achieve. While both classroom teachers and museum educators have the similar goal of educating students, they approach it from very different perspectives. Elementary teachers are usually responsible for educating their students across all subject areas and must make sure that their students can meet the standards that are expected of them. Museum educators can focus on the content and philosophy of their individual site, and are not held accountable for the learning of students who visit their museum.

There also seems to be somewhat more complicated issues involved. In a study by The Franklin Institute Science Museum (1992), the authors suggested that schools and museums have not seen themselves as equal partners; maintaining that each feels that they are doing very different things in terms of science education, and one does not necessarily complement the other. There is also a common view of informal science educators as “pseudo-educators” (The Franklin Institute Science Museum, 1992; Russell, 1997). Some of this stems from the fact that there are no set requirements for the experience or degrees of informal educators. Claiming that “museum educators practice some of the best teaching in a community”(Munley, 1991, p. 14) may not be entirely accurate and may overestimate the teaching expertise of these educators. While many museum educators *are* exemplary teachers, many do not have the experience or training to serve as model teachers. For this reason, many school administrators and teachers may not view the informal community as a competent partner in science education. Yet, this may be changing. For example, the new Center for Informal Learning and Schools funded by the National Science Foundation will include the training of graduate students and postdoctoral fellows in innovative methods of science teaching in a joint university-museum setting (Exploratorium, 2001). Establishing standards for informal science educators has the potential to positively impact future collaborations between the informal science community and schools. Hopefully, more educators will see the education of students as the responsibility of the *entire* community and not simply under the domain of the schools.

As increasing emphasis is placed on the role of the community in education, many in the museum community are insisting that they must work as a whole to forge strong partnerships with schools so that "large museums and museum consortiums join with school districts to develop long-range plans for their communities" (Munley, 1991, p. 14). Munley (1991) insists that no one should be satisfied with the museum educator and teacher working against the odds to create valuable learning experiences for their students. While Munley (1991) asserts that these relationships are valuable, the museum community and school system need to both reorganize and commit to these relationships in a larger sense. Yet, as Hirzy (1996) points out, teachers *are* the ones who most influence whether these relationships are realized. Understanding more about the teachers who continue to use informal science greatly informs the issue of making long-term connections. These connections simply cannot be made without the enthusiastic support of teachers. And, on a broader scale, it is widely agreed that teachers are the key to long-term, effective school change (Haney and Lumpe, 1995; Ramey-Gassert, 1997). Focusing on effective teacher use of informal science and their *perspectives* on their use of informal science therefore greatly informs this issue of linking the informal science community with schools.

FACTORS INFLUENCING TEACHERS TO TAKE FIELD TRIPS

The focus of this study is on teachers who use the resources of informal science on a continual basis. What then are the factors influencing them to use informal science? Once again, the literature on this subject appears to be focused on the actual field trip and not on using informal science resources in varying ways and on a continual basis. There are several studies that address this issue of the factors influencing teachers to take field trips.

Lessow (1990) surveyed 585 elementary teachers on their use of informal science and used quantitative analysis to determine possible correlations between teacher characteristics and use of informal science. Some of his major findings were that teachers took more field trips when they had taken personal trips to a particular site, felt that their students gained either cognitively or affectively and they had the power to select the site. Interestingly, Lessow (1990) did not find that those teachers who reported having a science related hobby, read science journals or attended more professional development took more field trips. And those teachers with more experience teaching also did not take more trips than other teachers. While this study had some interesting findings, it did not reveal the nature of these trips or teachers' personal thoughts on taking them. While Lessow (1990) addressed the effectiveness of the field trips, this was determined solely through survey answers and focused around the reported use of pre-visit and post-visit activities. Therefore, how these teachers used these sites was never revealed.

Michie (1998) interviewed 28 secondary science teachers in Australia to determine the influences on them to organize and conduct field trips. It was found that teachers mainly took field trips in order to give students hands-on, real life experiences which they could not have in the classroom. He also found that while there was some confusion on the usefulness of field trips, most teachers recognized the cognitive gains associated with the trips. There were some teachers who commented on the affective values. In addition, the majority of the teachers expressed that they would like to be able to take more field trips, but that a lack of time and effort often hindered this. Transportation, money, and large class sizes were also seen as obstacles to taking more trips. These teachers varied in how much they depended on the resources of the informal site to help them plan and prepare for their trips. Some reported that they would like to see more assistance from the informal sites, while others were more comfortable preparing for the trips on their own. This study also found that as teachers matured in their teaching practices, they reported that they had become more effective in leading field trips. Michie (1998) addressed the issue of past experiences and specifically asked the teachers how their attitudes towards field trips may have been affected by their past experiences. He found that the main factor which affected many teachers' willingness to take field trips was their past successful experiences on field trips as both teachers and students.

Michie (1998) provides great insight into teachers' thoughts about field trips – particularly as they relate to students and obstacles to taking trips. It is focused on secondary-level teachers where the field trips were most often scheduled by the school. And once again, it is focused on the one-time field trip, not on continued use of informal science resources by teachers who have the power to choose this. So, while this study is very valuable in that teachers' thoughts on field trips are reported, their *decision* to use informal science was not.

Mullins (1998) focuses on how outdoor field trips affect teachers and students. This is a qualitative study based primarily on observations of teachers and students of all ages and levels of study in field experiences at several different outdoor sites. In addition, six more experienced teachers ranging from an elementary teacher to a college professor were selected for follow-up interviews. These veteran teachers reported that they conducted field trips for three major reasons. The first was due to the positive benefits they and their students receive in terms of the relationships that developed among students, between students and teachers, and between students and informal educators. Mullins (1998) reported that these relationships "raised self-esteem, revitalized lives and enhanced their questioning and learning" (Mullins, 1998, p. 165). The second reason these teachers chose to take these outdoor trips was that they recognized that their thinking on how learning takes place had changed after engaging in these environmentally based trips. They realized the value of interactive learning and project-based learning where the students were involved in real-life projects. The third reason these teachers took these trips was simply because of the experiential benefits. They said that nature taught them how to teach; and that watching students connect with nature was their main reason for conducting field trips. This study also reported that most of the more experienced teachers had all had positive field experiences as children whether with their school or family.

Mullins (1998) is valuable to the issue of the reasons teachers use informal science in that it allows teachers' voices to be heard and addresses specifically those teachers who are more experienced in using informal science and have chosen to make it an important part of their teaching. This study was done from an environmental education perspective as opposed to a general science education perspective. The focus was on using nature specifically as part of teaching. And once again, this study was centered more on field trips specifically and not the teachers themselves, nor on the continued use of the informal sites – although Mullins (1998) did describe the benefits to teachers of workshops and other services offered by the sites. In addition, only one of these teachers was an elementary level teacher.

TEACHERS' EFFECTIVE USE OF INFORMAL SCIENCE

Most teachers find it difficult to use informal science in their teaching, and of those that do, most do not use it effectively (Griffin and Symington, 1997; Lessow, 1990). Griffin and Symington (1997) investigated the strategies used by teachers before, during and after field trips to a museum. They found that the teachers used mainly task-oriented teaching practices and made little effort to link their class curriculum with topics in the museum. If teachers' effective use of informal science is important to understand, then what is considered *effective*? Again, the research on this subject focuses specifically on "taking field trips" and not "using the resources of informal science." Features of successful student visits to museums reported in the literature include:

- Pre-visit preparation: This includes preparation on both the topic to be studied on the field trip and orientation to the site (Falk and Dierking, 1992; Koran, Morrison, Lehman, Koran and Gandara, 1984; Kubota and Olstad, 1991; Mullins, 1998)
- Integration of the visit with a classroom-based learning unit (Griffin and Symington, 1997; Orion, 1993; Storksdieck, 2001)

- Using a learner-centered approach where students are finding answers to their own questions (Griffin and Symington, 1997) and a process orientation over a content-based orientation (Orion, 1993)
- Encouragement of social interactions between peers and between students and adults through group work and limited unstructured time (Griffin and Symington, 1997; Mullins, 1998).
- Follow-up activities and time for open discussion (Mullins, 1998; Orion, 1993)

These components of a successful field trip described in the literature focus mainly on the actions teachers take in planning and conducting field trips. In order for a field to truly be effective, it should be a natural extension of a teacher's approach to science teaching.To take this to a deeper level, it is helpful to look at what might be considered "effective science teaching" on a broader scale and then apply this to using informal science resources

Effective Science Teaching

In order to provide a picture of effective science teaching, I refer to two high-profiled reports that have provided standards for quality science teaching. In the report, *Before It's Too Late,* The National Commission on Mathematics and Science Teaching for the 21st Century (2000) appointed by the U.S. Department of Education, described high-quality teaching as having the following characteristics:

- Teachers must have a deep knowledge of subject matter.

- The process of inquiry, as opposed to "giving instruction", is the teaching philosophy. Students are taught what to learn and *how* to learn.
- Teachers not only encourage students to learn, but insist they learn.
- There is an emphasis on observation, information gathering, sorting, classifying, predicting and testing.
- Students are encouraged to try new possibilities and solutions.
- Different learning styles and abilities of students are recognized. Teachers build on the strengths of students.
- Curriculum, assessment and high standards are carefully aligned.
- Teachers must be supported through professional development, the use of technology and recognition.
- Students are assessed to determine the effectiveness of the teaching.

The *National Science Education Standards* (National Research Council, 1996) provides a more detailed description of what is considered effective science teaching. They divide these into six standards where teachers of science…

- Plan an inquiry-based science program for their students. "Inquiry into authentic questions generated from student experience is the central strategy for teaching science" (p. 31)
- Guide and facilitate learning. "At all stages of inquiry, teachers guide, focus, challenge, and encourage student learning." (p. 33)
- Engage in ongoing assessment of their teaching and of student learning. "Skilled teachers guide students to understand the purposes for their own learning and to formulate self-assessment strategies." (p. 42)

- Design and manage learning environments that provide students with the time, space, and resources needed for learning science. "Teachers of science need regular, adequate space for science." (p. 43)
- Develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. "Effective teachers design many activities for group learning, not simply as an exercise but as collaboration essential to inquiry." (p. 50)
- Actively participate in the ongoing planning and development of the school science program. "Although individual teachers continually make adaptations in their classrooms, the school itself must have a coherent program of science study for students." (p. 51)

Central to both of these descriptions of effective science teaching is the notion of *inquiry teaching*. The phrase, *inquiry-based science*, is used so often in education literature that its true meaning is often distorted. This is because inquiry teaching encompasses a range of teaching practices and is often mistakenly identified by one of these alone. In a monograph published by the National Science Foundation (1999a), inquiry is the focus of a chapter on "A Vision of Effective Science Education". It is described in the following way.

> Inquiry teaching leads students to build their understanding of fundamental scientific ideas through direct experience with materials, by consulting books, other resources, and experts, and through argument and debate among themselves. All this takes place under the leadership of the classroom teacher. The process of inquiry is modeled on the scientist's method of discovery. It views science as a constructed set of theories and ideas based on the physical world, rather than as a collection of irrefutable,

> disconnected facts. It focuses on asking questions, considering alternative explanations, and weighing evidence. It includes high expectations for students to acquire factual knowledge, but it expects more from them that the mere storage and retrieval of information. (National Science Foundation, 1999a, p. 7).

Hands-on science is not necessarily inquiry-based science if no unifying concepts are introduced, no opportunities for student questions and follow-up are allowed, and there is no real structure to the exercise facilitated by the teacher. The teacher should ultimately be modeling and teaching the skills of lifelong learning. According to St. John (1999) good inquiry is "being good at knowing what you do not know" (p. 109). He argues that that's exactly the opposite of what is actually happening in schools. Most classrooms focus on what students' are supposed to know, and leaves them unprepared for dealing with the things they do not know. Therefore, teachers who are comfortable in knowing what they do not know and are enthusiastic about the process of discovery, make for more effective science teachers. As stated in the National Science Standards, "Teachers who are enthusiastic, interested, and who speak of the power and beauty of scientific understanding instill in their students some of those same attitudes." (National Research Council, 1996, p. 37).

Effective Science Teaching as Applied to the Use of Informal Science

If this is a vision of effective science teaching, then what might this look like in terms of teachers' use of informal science? Griffin and Symington (1997) address this issue in teachers' use of the individual *field trip* specifically. They advocate the teacher as facilitator rather than as director in order to establish a learner-centered approach. They provide the following example of a successful field trip:

> The teacher and students move into the museum in a group. In the foyer, the teacher sits with her class and together they compare the maps in their hands to the building. They look at some displays nearby to see how they include real objects, text and often some interactive elements. The teacher reminds the students of their discussion at school how each of these components will help them to find information on the aspect of the topic they have been studying at school. The students take another look at their books which contain the questions they have prepared before the visit.
>
> The students break into small groups, each with a parent. Each group has its own areas of inquiry to follow. One member of the group is carrying a paper and pen. Another member is carrying a camera and another a tape recorder.
>
> They move off into different directions. As they leave, the parent ask the students where they would like to go first.
>
> The teacher moves among the groups and shares her learning with the students, expressing interest in the displays and activities that they meet and asking questions to stimulate deeper thinking about the displayed information.
>
> After about an hour, the groups start to drift back to a central area to sit and have a break. The students enthusiastically share their findings with their friends in other groups. It is not long before the groups are keen to move on to new areas to find more information for their projects.
>
> After about 2 hours, the teacher moves through the museum reminding each group that it is time to go back toward the foyer, ready for departure. She finds some students using computer interactives, some watching a video, some writing notes, some quietly viewing displays and others discussing and comparing information in different displays. They are all eager to show her all the information they have found that will help them complete their projects back at school. (Griffin and Symington, 1997, pp. 776-777).

This example emphasizes a student-centered approach where students have devised their own questions to investigate and the teacher acts more as an interested facilitator. This models the use of inquiry-based teaching, facilitation by the teacher and collaborative, group learning advocated by the National Research Council (1996) in the *National Science Education Standards*. While this is an effective model of an individual field trip, how a teacher might choose to use the resources of informal science in varying ways has not been connected back to high-quality science teaching.

THE "GOOD SCIENCE TEACHER"

The teachers selected for participation in this study were often referred to as "good science teachers". They might have been called the "science person" at their school or the one that is known to plan and organize science-related events. I heard them described many times as simply a "great teacher" by parents, other teachers and museum educators. So, what then is a "good science teacher?" In a recent article, Cruickshank (2000) reviews the variations on the notion of the good teacher. There is obviously no agreed upon definitions of what encompasses a good teacher. Yet, there have been many trends in the literature and media of what this means. Cruickshank (2000) asserts that these are not independent or mutually exclusive. These descriptors of what defines a good teacher include: ideal, analytic, effective, dutiful, competent, expert, reflective, satisfying, diversity responsive and respected. Ultimately, this is personal opinion. It is also something, I believe, that is individualistic and difficult to generalize. However, the *National Science Education Standards* (National Research Council, 1996) and the characteristics of quality science teaching described in the report, *Before It's Too Late* by The National Commission on Mathematics and Science Education

(2000) described previously can provide a general framework for understanding the characteristics of a good science teacher. Another picture of effective science teaching is revealed in the criteria for the prestigious Presidential Award for Excellence in Science Teaching. This award was established by the White House in 1983 to recognize outstanding science teachers in the United States. Initially focused on secondary level teachers, this award was expanded to include elementary level teachers in 1990.

These teachers must demonstrate:

- Subject matter competence and sustained professional growth in science and in the art of teaching;
- An understanding of how students learn science;
- The ability to engage students in direct hands-on inquiry;
- The ability to foster curiosity and to generate excitement among students, colleagues, and parents about the uses of science in everyday life;
- A conviction that all students can learn science, and a sensitivity to the needs of all students' cultural, linguistic, learning, and social uniqueness;
- An understanding of the relationships of science and mathematics to each other and the interconnectedness of all subject matter;
- An experimental and innovative attitude in their approach to teaching; and professional involvement and leadership. (Horizon Research, Inc., 2001b).

While understanding the possible components of "good science teaching" is helpful, I believe that a glimpse of this approach to teaching is even more revealing. The National Science Foundation's (1997) publication, "The Challenge and Promise of K-8 Science Education Reform" contains a chapter entitled "A Vision of Effective Science Education." Below is a description of Ms. Strom's third grade unit on organisms and their habitats from this chapter.

> Ms. Strom's goal for the unit on habitats is to reinforce her third graders' growing knowledge of the basic needs of living things while developing in the students a basic understanding of the relationship between an organism and its habitat. As an initial part of the 6-week unit, students investigated habitats around the school, focusing their attention on a few organisms.
>
> By the fourth week, they have reviewed the basic needs of living things and have, by beginning with themselves and their own needs, explored the idea of complete and incomplete habitats. Then, in small groups, they looked closely at the needs and habitats of living organisms found within 2-foot-square plots in the area around the school. Through small and large group discussions, the recording of observations and data in their science notebooks, trips to the media center for reference books and other resources, and consultations with scientists over the Internet, the children's ideas began to crystallize. They began seeing how organisms are adapted to conditions in their habitat and how habitats provide the organism with the resources to meet its basic needs.
>
> On this particular day, Ms. Strom begins a component of the unit in which the students will build small terraria to temporarily house insects they have seen outdoors. The terraria will allow the students to study more closely how organisms are adapted to habitats. She begins with a discussion of the project and guides the students into thinking about a number of issues as they plan to construct the temporary homes. As Ms. Strom reviews with the students what they have learned, she is also assessing her students' readiness to pull together the knowledge gained over the past few weeks.
>
> The students then divide into their groups to decide which creatures they will collect and to plan terraria to meet the creatures' needs. Toward the end of class, the groups present their ideas and terrarium designs to each other for class discussion and critique. Ms. Strom takes an active role in this discussion, raising critical questions. Several of the groups revise and refine their plans. Later, they gather the materials and capture the creatures. Over the next four classes the students will observe their creatures closely, both within their temporary homes and in small bug boxes. At the conclusion of the exercise the student teams will present

> what they have learned, the class will discuss their findings, Ms. Strom will bring conceptual closure to the project, and the creatures will then be released in to their natural habitats (National Science Foundation, 1997, pp. 10-12).

While this description reveals the details of a class unit and contains the important elements of a well-designed science lesson, it does not describe the teacher herself. How does she feel about teaching science? What does she hope to accomplish in terms of teaching her students science? I believe knowing more about the teacher is important to understanding the relative nature of good science teaching.

So what then does the literature reveal about these good science teachers? A recent survey can provide a general indication. In a study conducted by Horizon Research, Inc.(2001b), the recipients of the Presidential Award for Excellence in Science Teaching were compared to science teachers nationally. Some of the ways that the elementary-level awardees differ from their national counterparts follow.

- They are more experienced. The majority has taught for more than 20 years.
- They are more likely to have earned degrees beyond the bachelor's.
- They are more likely to have extensive coursework in science.
- They feel more prepared pedagogically to teach science.
- They feel more prepared to use investigative strategies in their teaching.
- They feel well-qualified to teach all areas of science.
- They feel more prepared to involve parents in the science education of their children.

- They feel more confident in their science content knowledge.
- They spend more time in professional development.
- They are more likely to have served on school or district curriculum committees.
- They are more likely to have led inservice training.
- They are more likely to be "very familiar" with the National Research Council's (1996) National Science Education Standards.
- They perceive that they have more control over curriculum and instructional decisions.
- They are more likely to emphasize increasing interest in science, developing science process/inquiry skills, learning to explain science ideas, and learning to evaluate arguments based on scientific evidence. In contrast, the general population of teachers is more likely to emphasize learning science terms and facts and preparing students for standardized tests.
- They are more likely to use computers and other technology in their teaching.
- They are more likely to use student portfolios, notebooks/journals, class presentations, and long-term science projects in assessment. In contrast, the general population of teachers is more likely to assess students based on short-answer tests.

The teachers that receive this award are known to be exemplary teachers. And two of the participants in this study have actually received this award. The way that they approach teaching and their attitudes towards science have made them stand apart from other elementary teachers. The teachers selected for this study also stand apart from other teachers in that they are known to use informal science in their teaching much more than the average teacher. And using community resources is considered a part of effective science teaching. This is clear in a phrase in the National Science Standards (1996) which states, "The school science program must extend beyond the walls of the school to include the resources of the community" (National Research Council, 1996, p. 45).

Teachers' Attitudes Towards Science

One area that the researchers conducting this survey of Presidential Awardees for Excellence in Science Teaching did not address was teacher background in relation to their science teaching. Because this study addresses teachers' perspectives on their use of informal science and these are teachers known to be "good science teachers", I expected that they would have positive attitudes towards science and therefore feel more confident in their ability to teach science or have a higher science teaching self-efficacy (Ramey-Gassert, Shoyer and Staver, 1996). So what affects teachers' attitudes towards science? The research on this reveals several influences. Elementary and secondary level school experiences are strong influences where textbook-based, vocabulary-based curriculum being associated with more negative attitudes and more hands-on curriculum being associated with more positive attitudes (Ramey-Gassert et al., 1996; Talsma, 1996; Westerback, 1982; Young and Kellogg, 1993). The quality of preservice science methods courses (Pedersen and McCurdy, 1992) and science-related professional development courses (Qualter, 1999) has also been reported as a predictor of science attitude among teachers. Beyond the influences of formal schooling, Ramey-Gassert et al. (1996) and Talsma (1999) also point to the powerful role of parents in the development of attitudes towards science – especially fathers. Ramey-Gassert et al. (1996) also point to other positive informal experiences with science as a predictor of an efficacious science teacher. This includes things like growing up on a farm, and experiences with nature in Brownies or Girl Scouts. And for those teachers who developed more positive attitudes towards science later in life, many of them reported that raising their own children and/or watching children delight in science early in their careers prompted them to reflect more deeply on their science teaching (Ramey-Gassert et al., 1996; Talsma, 1999). And interestingly, Shrigley (1974) found a low correlation between science knowledge and teachers' attitude toward teaching science. Furthermore, Qualter (1999) found that effective science teachers did not discuss science content knowledge as being important to their ability to teach science. They focused more on pedagogy and the importance of their development of constructivist teaching methods. There is therefore more to the development of a positive attitude about teaching science than teachers' content knowledge.

Just as knowing what influences the development of positive science attitudes among teachers is informative to improving science education, so is knowing more about these teachers who reach out to their community in their efforts to teach science. Despite the increasing emphasis in the literature on creating partnerships between the informal science community and schools, many teachers are still not tapping into this valuable resource. Knowing more about those who do will help us understand why others do not.

STUDY FOCUS AS IT RELATES TO THE LITERATURE

While the literature concerning the factors influencing teachers to take field trips is informative, it lacks a clear picture of the elementary level teacher who chooses to continually use the resources of informal science. I believe that the elementary level teacher is of particular interest because this is the level that the majority of resources at informal science sites are designed for (Inverness Research Associates, 1990) and the classes are likely to be self-contained and therefore more conducive to coordination of field trips and the use of other informal science resources. Further, at a time when the majority of elementary teachers do not feel well-qualified to teach science and are teaching less science (Horizon Research, 2001a), hearing from those elementary teachers that *do* feel confident in their ability to teach science and incorporate informal science in their teaching can inform this issue.

While many teachers will take their students on at least one field trip during the year, fewer will lead *effective* field trips where students gain both cognitively and affectively. Many teachers will use it as a reward or will not integrate it into their curriculum (Lessow, 1990). The field trip models described in the literature focus on the one-time field trip, and yet longer-term partnerships and projects are what is ultimately desired by those from both the informal and formal sectors of education. There are some teachers that have formed their own unique relationships with informal science sites and are able to use them in a variety of ways – beyond the one-time field trip. And while the one-time field trip is a vital part of their science teaching, the informal science site serves as a resource in many other ways. Unfortunately, these teachers are not commonplace and their stories are therefore worth listening to.

Surprisingly, the research on teachers who have continually used informal science resources is relatively sparse. Most of the literature dealing with museum education has tended to focus on the museum learning experiences of individual and family visitors (e.g., Bitgood, Serrell and Thompson, 1994; Duckworth, 1990; Falk and Dierking, 1992; Hein, 1998; Hein and Alexander, 1999) and the literature on museum-school partnerships has mostly been done from institutional perspectives where the emphasis is on forming formal partnerships (e.g., Hirzy, 1996; Russell, 1996, 1997; Sheppard, 1993; The Franklin Institute Science Museum, 1992), primarily addressing structural issues such as system size, governance, mission, and funding sources. And while there have been descriptive examples of successful museum-school partnerships published (e.g., Hirzy, 1996; The Franklin Institute Science Museum, 1992), these do not focus on the perspectives of those people involved. They instead emphasize the partnership itself and the programs produced – on an institutional level. And yet, it is widely agreed that teachers are the key to long-term, effective school change (Haney and Lumpe, 1995; Ramey-Gassert, 1997). Ramey-Gassert (1997) warns that state and local reform will encounter resistance, resulting in short-term change, if teachers' beliefs and attitudes are not considered.

The studies that deal directly with teachers and informal science are either quantitative where there is an absence of teachers' voices (Lessow, 1990) or address the perspectives of students, informal educators *and* teachers so that the focus is not solely on teachers (Mullins, 1998). And Michie (1998) focuses mainly on the obstacles to field trip planning and deals with secondary level teachers as a whole. Perhaps more importantly, the literature on this topic is focused on the field trip and not the teacher who uses informal science sites in unique ways. I believe that focusing on the *teacher*, and not solely the *practice* of using informal science is valuable in understanding and addressing the topic of teacher use of informal science. Goodson (1992) argues that focusing on teacher practice alone cannot possibly capture what is needed to ultimately seek reflection and change in teacher practice. This is because when teachers talk about issues related to their practice, they constantly include information on their own lives. Goodson (1992) states that this is evidence that teachers themselves consider this to be of major importance.

This study specifically addresses the perspectives of elementary teachers who use informal science regularly in their teaching. These teachers are known to be strong science leaders at the elementary level and use informal science often for more than a one-time field trip. Hearing teachers' perspectives and readers seeing themselves or others they know reflected in their stories may help create more and better relationships between the informal science community and schools.

Chapter Three: Methodology

RESEARCH PARADIGM

The research question "Why and how do teachers continually use the resources of informal science education sites?" is best answered by the teachers themselves because it is they who ultimately decide whether or not to continually use the resources of a particular site. A district or school may initiate first contact with an informal education site, but those teachers who use informal science regularly for a variety of reasons do so because they themselves have chosen to. I therefore focused on the teachers, rather than the institutions involved.

This study is situated within a constructivist paradigm in which the researcher takes the position that, as Schwandt (1998) states, "…human beings do not find or discover knowledge so much as construct or make it" (p. 237). The constructivist paradigm recognizes the multiple realities of individuals and the complex nature of those realities. In other words, there is no single, unique "reality" but only individual perspectives.

Since there is no one "reality" according to the constructivist paradigm, context plays an important role. Erlandson, Harris, Skipper and Allen (1993) emphasize that since no two contexts are identical, full generalizability within this paradigm "ignores the unique shaping forces that exist in each context" (p. 17). The contexts described in this study include different school and professional environments, in which these teachers are involved. And while they have participated in many of the same informal science activities and programs, they have also had many unique experiences and have approached these opportunities from their own personal perspectives. Each of the participating teachers' experiences with the various informal science sites in the area has been different, as well. Therefore, the results of this study could not possibly apply to all situations involving teachers and science museums.

Yet, parts of this study may relate well to other teachers' situations involving the use of informal science. A reader can only determine this if a thorough description is presented. Erlandson et al. (1993) emphasize that a well-done study in this paradigm explains a context as fully as possible. This allows for two possibilities: direction for dealing with future situations in the same settings or direction in understanding situations in similar settings (Erlandson et al., 1993). Understanding the "whole" is the goal; and this can begin through an investigation of any portion of it. As Erlandson et al. (1993) point out, "By 'understanding the whole' we refer to a working comprehension of the interrelationships that give definition to it" (p. 14). By writing in a way that allows the reader to enter into the research context - in this case, teacher experiences with informal science- I provide what is often referred to as rich, thick description of participants' perspectives (Creswell, 1998; Lincoln and Guba, 1985). In this way, I have tried to reveal these teachers' stories so that readers can pull from them what is relevant and useful in their own settings. This is also referred to as transferability (Erlandson et al. 1993; Lincoln and Guba, 1985).

Given that rich description of context is important to research based in the constructivist paradigm, transferability cannot be increased through logical generalizations or increased amounts of data (Erlandson et al., 1993; Lincoln and Guba, 1985). This would only lead to convergence of data and the misleading appearance of clear boundaries and overarching conclusions - not to an increased understanding of the "whole." Only by revealing the rich complexity of situations can they be better understood. Erlandson et al. (1993) point out that

> [Researcher and reader] interpretation is both limited and enriched by context. Interpretation is limited as context drives constantly toward greater specificity; at the same time the accumulation of specific detail provided by context describes a set of intricate relationships that bring the researcher or reader vicariously into the setting. (p. 18)

In this study, I specifically chose to focus on six different teachers in order to provide some diversity of experience. Yet, I also chose to limit it to six teachers so that I could provide full descriptions of their perspectives on these experiences. Much of the responsibility of determining the "usefulness" of the study is placed on the reader (Lincoln and Guba, 1985). The researcher provides the context description, and in the process, provides their own re-telling of the participants' stories. Yet, the reader must decide how the findings relate to his/her own situation. For example, a museum educator reading this study may at first notice that an informal science site described seems nothing like hers because it has an environmental focus (where hers has a medical focus) and is mostly located outdoors (while her museum contains mostly indoor exhibits). Yet, considering the description of the teacher's perspective of her experiences at this informal site, she sees that one of the museum educators has a way to meet the needs of teachers who want to spend more time a their site. This reader makes notes on ways that the situations are the same and different, so that she may discuss solutions with colleagues as they relate to her own museum. This was a connection that I, as the researcher, may not have predicted. And yet, I would have provided the context so that the reader could do this herself.

However, constructivist research does not simply consist of telling the stories of others, because, as the researcher, one is ultimately *re-telling* these stories. The constructivist researcher believes that exploring others' perspectives of the world is actually a co-construction between collaborators in which the researcher strives to relate the stories of the participants as closely to the participants' perspectives as possible. Yet, some sort of interpretation cannot be avoided simply due to the fact that the researcher is telling someone else's story, and not their own. In this paradigm, the researcher is the primary instrument in gathering and analyzing data and therefore, the research report is actually a result of co-construction and analysis of data (Lincoln and Guba, 1985). Throughout this study, each participant and I have co-constructed their stories. I gathered what they have said and put it into summaries from which they made revisions and additions, as needed, until it adequately represented what they believe to be relevant and true to the focus question of why and how they use the informal science. It is from this that I have pulled emergent themes and described these for the reader.

In qualitative research, the researcher is the most important instrument (Ely, Anzul, Friedman, Garner and Steinmetz, 1991). It is the researcher who decides how to sample, what data to collect, and how to treat that data; and it is the researcher who chooses how to portray the participants' stories. Therefore, the research study can only be fully understood if the perspectives of the researcher are taken into account because they ultimately shape the study. In line with this, I have provided a "Researcher as Instrument Statement" (see Appendix A) which describes my interest in the topic, my choice to pursue it as a research focus, and my beliefs and values as they relate to the study. This statement was written in the fall of 1999 before I began the pilot study for this research. While the ultimate goal is to report the participants' stories as they perceive them, as the researcher, I have analyzed the data from my own perspective**.** Therefore, I ultimately shaped the presentation of findings in terms of the form in which I chose to portray the participants' stories and the manner in which I describe emergent themes. Some of these choices may be traced back to what I have written in my "Researcher as Instrument" statement. Readers can therefore trace my influence on the study and more clearly hear the participants' voices. In line with this, my interpretations are clearly pointed out in Chapter Six of this study report.

My perspectives are also evident in my reflexive journal (see Appendix C.1). This is where I routinely recorded my thoughts, philosophical positions and actions taken as they related to the study (Lincoln and Guba, 1985). Objectivity can obviously never be achieved; but by understanding my beliefs, past and present experiences and values as they relate to the study's focus, readers of this study can come closer to understanding the perspectives of the participants.

RESEARCH STRATEGY

Remaining consistent with the constructivist paradigm, I used a naturalistic inquiry strategy as described by Lincoln and Guba (1985) and Erlandson et al. (1993). This strategy rests upon the rejection of a priori theory as a basis for analysis and emphasizes the researcher as the most important instrument for data generation and analysis. The emphasis in naturalistic inquiry is on the perspectives and experiences of the participants – from which the researcher's descriptions of emerging themes are based.

There have been two sets of quality criteria described in the literature for a naturalistic study's results: 1) trustworthiness, which, if established, allows readers to make a reasonable assumption of methodological soundness (Lincoln and Guba, 1985), and 2) authenticity, which speaks to the importance of relationships with participants with an emphasis on fairness and personal benefits (Guba, as cited in Patton, 1990; Manning, 1997) In designing this research plan, I carefully considered the methods needed to establish a quality study. Procedures for establishing trustworthiness and enabling authenticity will be discussed as they relate to my data generation and analysis.

STUDY SAMPLE

To address my focus of teachers' perspectives of why and how they continually use informal science resources, I interviewed and observed six elementary teachers who have used the informal science resources on a regular or repeated basis. "Regular" means that they have either returned to sites more than once, that they have visited multiple sites over the course of a school year, or they have worked with an informal science site in some other capacity on a repeated basis. The basic premise is that they have used informal science more than the average teacher. While most elementary teachers visit informal sites once or twice a year with their grade level, these are teachers who are known to seek out informal science and use it more. There was no strict definition of how or how often they use informal science.

I chose to look at teachers who use informal science regularly because I believe they can reveal not only why and how they personally use this resource, but this in itself can potentially reveal information about why other teachers might *not* be using museums. In the pilot study for this research (Youker, 1999), the teachers discussed how they were seen as “different” at their school. They also discussed their frustrations with state and district mandates that could often disrupt what they really wanted to be doing with their students. In this way, the perspectives of these teachers who *do* use museums may very well shed light on why others are not.

I chose to focus on elementary teachers because elementary classrooms are largely self-contained, and students tend to have fewer teachers than in middle and high school. Because one teacher often teaches all subjects, the teacher can more easily integrate museum material into multiple levels of the curriculum and into several subjects. The museum can therefore fulfill many needs. In addition, since students are primarily assigned to one classroom, teachers can also integrate field trips into their plans with less difficulty than a middle or high school teacher, whose coordination with other teachers’ schedules can be tricky. Middle school and high school teachers may also not be able to bring their students on as many return visits, simply due to scheduling difficulties. I would like for this study to have something to offer most institutions, and focusing on elementary teachers could help make this happen. Yet while I have chosen to limit the sample to elementary teachers for the purposes of this study, I do not wish to downplay the importance of partnerships between high school and middle school teachers and museums; my goal is to reach those who are likely to use informal science institutions the most.

The teachers who participated in this study came primarily from the recommendations of museum educators. They were difficult to find because I found that there were not many teachers who used informal science regularly. Three of the teachers came from recommendations from a museum educator who had partnered with these teachers on projects in the past. A fourth teacher was found due to a conversation with another museum educator on how teachers tended to use that particular museum. She said that this teacher had been a very involved summer camp teacher who returned frequently. A fifth teacher was found due to a recommendation from a colleague who worked at the state level in education and knew that this teacher was an "involved" and "resourceful" science teacher. The sixth teacher was found when a museum educator simply searched through computer files for "return teachers".

While I looked for diversity - in terms of the grade levels they teach, school demographics, number of years teaching, gender and ethnicity – to increase the opportunities for transferability, the fact that these teachers were difficult to find limited my ability to be more selective. In fact, two of these teachers were not found until I was two months into interviewing. Yet, these teachers were definitely diverse – at least in terms of their teaching. Four of them teach in the larger school district, Jonestown I.S.D. which is diverse both in terms of income level and ethnicity, while the other two teachers are in smaller, more affluent and mostly white school districts right outside of Jonestown. All of the teachers are white, with two males and four females. And while they have all had over 10 years of experience, the schools they teach at vary greatly. Greg teaches a class of fifth and sixth graders at a school that serves largely low-income Hispanic families. He has been teaching for 14 years. Betty has also been teaching 14 years and teaches fifth grade math and science at another school that largely serves low-income Hispanic families. Joe teacher teaches fifth grade at a largely white, middle to high income school. He has been teaching almost 20 years. Vicki has been teaching 17 years and teaches 3rd grade at a school in a mixed area which serves a wide variety of families in terms of ethnicity and income level. Kathryn teaches first and second graders at a school in a higher-income area. She has been teaching almost 30 years. And Suzanne teaches kindergarten also at a school in higher-income area. She has been teaching 24 years.

DATA GENERATION

The majority of data generation took place between February 2001 and June 2001. Data generation included emergent interviews with the teacher participants (see Appendix D.1). This method consists of asking one open-ended question and allowing the participant to lead the interview; this method is also called unstructured or open-ended interviewing. Before I began each initial interview, I explained the emergent nature of the interview process and asked each of them to review and sign the consent form (see Appendixes B.1 and B.2). The interview began with the question, “Why and how have you continued to use the resources of informal science?” Lincoln and Guba (1985) explain that “the unstructured interview is the mode of choice when the interviewer *does not know what he or she doesn’t* know and must therefore rely on the respondent to tell him or her “ (p. 269). The participant, therefore, was encouraged to introduce what he or she sees as relevant; the goal was to capture the participant’s perspective rather than to frame it in some way. Follow-up questions were based on what the he or she had already said. These interviews were done both face-to-face and on the telephone. Once the first interview was completed in person, I informed each participant that we could have any further interviews on the telephone. Each interview lasted between 45 minutes and 90 minutes. Additional interviews were done until data saturation was reached with each participant, where the participant began repeating the same ideas mentioned earlier, with no new ideas emerging. The number of interviews per participant was between four and five.

These interviews were audio taped, transcribed and member-checked. Member checking involves soliciting feedback from participants on the researcher’s understandings, interpretations and findings (Schwandt, 1997). According to Lincoln and Guba (1985), this is the most important procedure for establishing credibility. Credibility is an important element in establishing the trustworthiness of a study’s results and refers to the “truth value” of the findings

(Lincoln and Guba, 1985; Schwandt, 1997) or the extent to which the researcher's described findings match the participants' perspectives. Member checking was conducted during interviews by asking participants clarifying questions and requesting that they comment on summaries I relate back to them (see Appendix F). I also member checked in follow-up interviews by asking additional and clarifying questions based on information gathered in earlier interviews. Once data saturation had been reached, I also provided participants with written summaries of the interviews for them to review and correct (see Appendix F). This process of member checking is important because it allows participants to indicate whether the descriptions and interpretations made by the researcher are familiar to them.

Because two of the participants had been a part of a 1999 pilot study for this research, I also included the data from those interviews as well. The pilot study was focused on the same research question of why and how teachers use informal science on a continual basis. I obtained consent from these teachers in order to use that data, and followed with further interviews until data saturation was reached.

The second data type was observations. I observed teachers' visits to informal science sites. I was able to observe 5 of the 6 participants on these trips. One of the teachers, Betty, was not as involved in informal science at the time and only took one trip that school semester. This was an overnight trip to Port Conner, which occurred immediately before we began our interviews. I realized before I began data generation that the feasibility of observing all teachers using informal science would not be predictable because of the fact it is not something they do everyday. Furthermore, it was not something I knew before we began our interviews. Yet, my interviews with Betty took place in her classroom, so that I was able to observe her classroom and she showed me many of her materials and described her science teaching. The observations of the other teacher participants were as follows:

- Greg was observed leading his students on a follow-up trip to the Nature Center to collect data for a long-term pond study project.
- Suzanne was observed leading her students on a field trip to the Wildflower Center.
- Joe was observed while on a city-sponsored field trip to a water treatment plant.
- Kathryn was observed taking her students on a trip to the Nature Center.
- Vicki was observed leading her students on a trip to the Museum of Science and History.

I took notes during the observations and I wrote down further reflections immediately afterwards (see Appendix D.2). These were also member-checked with the teachers through written summaries and follow-up discussions.

In addition to interviews and observations, I also collected any relevant documents (see Appendixes D.3 and D.4). These included museum curriculum materials or teacher resource material, teachers' lesson plans related to the their science teaching or use of informal science, and any other documents they saw as pertinent to their use of informal science. For example, Suzanne offered me her science curriculum she had written which was closely tied to her use of informal science. And Joe suggested I review an article on his use of technology in the classroom that he co-wrote. I also include in this definition of relevant documents any online documents that directly related to these participants. Greg and Joe both have websites related to their science teaching and use of informal science from which I obtained documents to use in analysis. The inclusion of relevant documents in data generation further establishes credibility through triangulation of data types. Through gathering and analyzing data from interviews, observations and documents, my goal was present a more holistic picture of why these teachers continually use informal science.

Because I provided participants with multiple opportunities to express themselves – through documents such as those mentioned above, multiple open-ended interviews, and member checking – I am addressing the quality criterion of authenticity with regard to fairness. Fairness can be described as the extent to which the participants' different constructions and their underlying values are solicited and presented in a balanced way (Erlandson et al., 1993; Manning 1997; Schwandt, 1997). The fact that I obtained their informed consent to participate in this study also helps to establish fairness.

Authenticity actually has five parts, consisting of fairness and four other types of authenticity: ontological – the extent to which participants' conscious understanding of the world was enhanced or informed by the study; educative – the extent to which participants became aware of the constructions of other participants in the study and subsequently understand them better; catalytic – the extent to which action was inspired by this study; and tactical – the extent to which participants take action as a result of participation in the study (Erlandson et al., 1993; Manning, 1997; Schwandt, 1997). These final four components of authenticity were out of my control as the researcher, but I was hopeful that my study design would bring about at least some measure of personal growth for participants and increase their understanding of others.

DATA ANALYSIS

Data analysis actually began with data generation because I was already thinking about the data and making notes as I interviewed, transcribed and summarized. Data generation and data analysis are actually inseparable (Erlandson et al., 1993; Ely et al., 1991); and yet, the process of analyzing data can be thought of as occurring in two stages. The first occurs during the process of data generation and the second occurs in a place separate from the researched environment - when the majority of data analysis takes place. Lincoln and Guba (1985) describe this process as one that "involves taking constructions gathered from the context and reconstructing them into meaningful wholes" (p. 333). There are three main elements to the data analysis process: 1) unitizing data – where data are sectioned off into separate ideas where each one can stand alone (see Appendix E.1 and see Appendix E.3 for list of codes), 2) emergent category designation – where units of data are separated into descriptive categories of ideas (see Appendix 5.4), and 3) negative case analysis – where alternative interpretations of the data are carefully considered, often by testing emergent categories against new data (Erlandson, et al, 1993; Lincoln and Guba, 1985).

This was not a linear process, but a recursive one. As new data were generated, the new codes were compared with existing codes and categories and were renamed or regrouped as necessary. This is often referred to as *bridging, extending, and surfacing the data* (Erlandson et al., 1993; Lincoln and Guba, 1985), and this process often occurs intermittently as the data are analyzed. The entire process obviously cannot be done in an orderly fashion; it takes many twists and turns. As Marshall and Rossman (1989) explain (as cited in Erlandson, et al., 1993):

> Data analysis in the process of bringing order, structure, and meaning to the mass of collective data. It is a messy, ambiguous, time-consuming, creative, and fascinating process. It does not proceed in a linear fashion; it is not neat. Qualitative data analysis is a search for general statements about relationships among categories of data; it builds grounded theory. (p.112)

As a tool in the analysis process, I used the computer software Atlas.ti version 4.2 developed by Scientific Software Development. This program helped me to organize and code the data.

After continued analysis, categories were grouped and linked in ways that pointed to *emergent themes* (see Appendix 5.4), which Ely et al. (1991) describe as meaningful statements that can be seen in all or most of the data, or one that does not run through all of the data, but that has a heavy emotional or factual influence. These themes were then tested against new data in further negative case analysis to ensure their coherence. The resulting emergent themes ultimately served as the primary study findings.

Because I am the research instrument for this study, I relied on my reflexive journal (see Appendix C.1) and peer debriefing group as my analysis aids. As previously explained, the reflexive journal was the place where I recorded my thoughts, philosophical positions, and actions taken as they relate to the study (Lincoln and Guba, 1985). I used it to organize my thoughts and clarify ideas; and it served as a record that I often returned to in order to track my reasoning for a methodological decision or return to a once-discarded idea. Entries were made at least three times per week, but the frequency varied depending on the stage of the research process. I tended to record more frequently during data generation as I made connections or developed insights before I "officially" began unitizing and coding the data. Because the journal serves as a place to record methodological decisions and insights, it supports the credibility of the study (Erlandson et al., 1993). It also supports two other components of trustworthiness: dependability and confirmability. Dependability can be described as the consistency of the study's findings. (Lincoln and Guba, 1985; Schwandt, 1997). In other words, if the study were repeated, would any differences in the results be trackable? Confirmability refers to the neutrality of the study – where the findings should reflect the focus of the study, rather than the researcher's bias (Lincoln and Guba, 1985; Schwandt, 1997). While it is difficult to certify the dependability and confirmability of a study without a thorough audit of the research process and product by a third party, member checking, the reflexive journal and the accompanying "Researcher as Instrument" statement support claims of both (Rodwell and Byers, 1997).

In addition to my reflexive journal, another important aid in my analysis was my peer debriefing group. It served to provide external reflection and input on the research process (Creswell, 1998; Erlandson et al., 1993; Ely et al., 1991). This group consisted of three to four other researchers in education – one left once she graduated. Another was currently working on her dissertation, another had recently completed her dissertation, and a third was completing her dissertation proposal. In addition, three of the researchers had completed a research course focusing on naturalistic inquiry and understood the strategy well. We met once weekly either together or in smaller groups, and regularly recorded the notes from these meetings (see Appendix C.2). The peer debriefing group served as a sounding board for questions and ideas related to my research, and helped in testing preliminary themes against new data. Members asked me difficult questions concerning methodological issues and meanings, and helped me consider alternate interpretations of the data. Therefore, these sessions provided an external check of the research process and therefore supported the credibility of the study (Creswell, 1998; Erlandson et al., 1993; Lincoln and Guba, 1985).

Credibility and confirmability were further supported in data analysis through continued member checks, during which participants were asked to review initial drafts of findings (see Appendixes E.2 and F). They therefore reviewed both interview summaries and the resulting themes. Because the aim of naturalistic inquiry is to portray the participants' perceptions, it is important that they agree with the plausibility of the findings.

Lincoln and Guba (1985) describe the final component of trustworthiness as transferability, which can only be ultimately determined by the reader. As the researcher, I have purposively chose a study sample of six elementary teachers who brought their own backgrounds, perceptions and stories to this study. I will make every attempt to set up the conditions for relevant transfer of the findings by providing rich descriptions of the contexts and findings.

SUMMARY

This study is situated within a constructivist paradigm in which the researcher recognizes the multiple realities of individuals and the complex nature of those realities. Additionally, it employs the use of naturalistic inquiry as described by Lincoln and Guba (1985 and Erlandson, et al. (1993) as the research strategy. The participants included 6 teachers who use, or have used, informal science resources on a continual basis. Data consisted of emergent interviews, observations and relevant documents. These were unitized and coded from which resulting themes emerged. In addition, the quality criteria of trustworthiness (Lincoln and Guba, 1985) and authenticity (Guba, as cited in Patton, 1990; Manning, 1997) were addressed for this study and described in this chapter. The following chapter, Chapter Four, describes the findings of this study in a case-by-case format where each teacher's story is described separately.

Chapter Four: Findings: Case-by-Case

I begin my findings section with a case-by-case description of the teacher participants in this study. Each of them offers a unique perspective on using informal science resources and they are described here based on my analysis of interviews, relevant documents and observations. I first reveal their relevant background and teaching experience and then describe their use of informal science.

I provide a cross-case analysis of the teacher participants in Chapter Five.

KATHRYN: INFORMAL SCIENCE IS AN ESSENTIAL RESOURCE FOR TEACHING SCIENCE AND GROWING PROFESSIONALLY.

I accompanied Kathryn and her class on a field trip to the Nature Center in the spring. Below is an excerpt from my journal, describing part of that experience. We had already been through the Nature Center's program and one of the staff led us out into the preserve for a short walk.

> The guide led us to the rocks of a little streambed. Then once the guide was done, Kathryn had the kids do some neat activities. She had them sit on a rock by themselves and close their eyes and listen. Everyone had to be very quiet. They heard two or three birds and some said they heard some insects, and others said they could hear cars in the distance. Then she had them pick one spot and stare at it for a few minutes. So they were all finding these very interesting things in the crevices of rocks and on the bark of trees. They were looking at snail shells and the kinds of rocks that were down there, spiders, lots of little inchworms. It was the beginning of spring, so they really had an appreciation for what was out there. The kids were all busy looking at things and took their task very seriously. They enthusiastically shared their findings with their friends and parents. Kathryn really models a true enthusiasm for science and the kids have obviously picked up on that. (Researcher's Journal Entry: April 2, 2001)

Background and Teaching Experience

Kathryn has been teaching for 29 years and has taught at four different schools in the Jonestown area. She has been at her current school, Miller Creek Elementary, for eight years. It is in a small, more affluent district right outside of Jonestown ISD. This school has a high number of high SES students and is predominantly white. Miller Creek Elementary was recently nominated for the prestigious Blue Ribbon School Award and Kathryn says that the lengthy, in-depth process of their school evaluation has proved to be a rewarding experience for all. She has taught kindergarten, first and second grades. At the time of the interviews, she was team-teaching multi-age first and second graders and was preparing to teach second grade the following year. She is known as an exceptional teacher by both her students and colleagues and among many awards, she was recognized with the Presidential Award for Excellence in Science Teaching – a select national award for extraordinary science teaching.

Kathryn has a deep love of both teaching and science. Interestingly though, Kathryn says that she did not always think she wanted to be a teacher.

> … I didn't want to be a teacher. I had teachers in my family. My grandparents were a principal and teacher. My aunt was a teacher. My dad was a geophysicist. My dad did not see teaching as a noble profession. He saw it as something that you did if you were a wife and you weren't going to have a career. It was like not even a career. You just went and did it.

Although Kathryn says that she did not consciously think that she would someday be a teacher, she tended to drift towards teaching growing up. She was always very involved in theatre and dance and would often teach classes to younger children. Yet, since she felt that teaching was not a well-respected profession, she pursued her other interests such as architecture. She says that she used to spend hours drawing house plans.

One of her greatest interests as a child was science. Kathryn said that she has always had an affinity for science. As she said, “ I’m pretty excited about exciting people about science…… I *love* teaching science. The kids *love* doing science.” She describes her mother as a naturalist and that she picked up every bug and lizard and showed it to her. Her father also had a big influence on her on that level.

> So Dad spent a lot of time with science with me. He’d always bring the brain teaser puzzles home and challenge me with them…….He would give me these bizarre problems and would try to get me to figure them out. He constantly was trying to say, “Oh, you’ve got to do something in science. You’ll love science.” And I did love science. I always did.

Kathryn found herself pursing an education degree after switching over from architecture. She says that now that she can reflect back on it, she sees how that happened because she was always drawn to teaching growing up but never officially acknowledged it.

The Professional Teacher

During our interviews, Kathryn spent a great deal of time talking about the many projects she is involved in outside of the classroom. Some of these include:

- leading teacher workshops on science teaching through a grant with an informal science institution,
- initiating her school’s participation in a worldwide project of data collection on weather,

- writing science curriculum on a local and national scale – several of these were in conjunction with the local Children's Museum,
- participation in the experimental stages of a national effort to bring air-borne astronomy research to students, and
- recognition as program instructor for several national science curriculum projects.
- active involvement in many science and science teaching organizations.

One of Kathryn's particular interests is marine science. Kathryn grew up on the coast and has always had an affinity for marine science. She is involved with the Marine Science Educator's Association and scuba dives whenever she has the opportunity. Kathryn has built a strong partnership with the university's marine science institute and credits them for instigating her to bring her love of marine science to her students.

Kathryn involvement in so many projects and organizations is what she says keeps her stimulated. She enjoys being constantly challenged and says she does not like to feel "stagnant" in her professional life. As she says, "I started doing presentations pretty quickly after I started teaching. Writing, curriculum writing, that kind of stuff. And that would stimulate me. I love teaching the kids, but what really keeps me going is this outside realm."

Kathryn's enthusiasm for her profession is in stark contrast to how her father envisioned teaching. She says,

> I got excited about it once I started teaching. I think what I envisioned teaching as being was not what I was willing to make it. There were teachers in my school that were exactly what my dad was talking about.

One thing that is apparent through all of Kathryn's involvement in these projects and organizations is her emphasis on science – and especially on the connections between scientists and educators. She has a strong desire to bring the language of scientists to her students. She has worked with astronomers, marine scientists and geologists on state and national committees on how they can bring educational components into their grants and projects. Kathryn has a wonderful ability to bring real science to the general public, and especially to her own students. She has been recognized for this and has therefore been involved in many interesting projects. She is clear on her role in these projects.

For example, on one particular project, Kathryn explains how it is *her* job to educate and the scientists' job to know the content.

> So they were trying to figure out what their direction would be. They pulled in some college teachers, and I was the elementary teacher, and they pulled in a high school teacher. We went to D.C. We just kind of brainstormed what this kind of thing would look like. And again, they would say, "Kids can't understand this." And it just takes a minute to say, "That's not your job. Your job is to do the science and make *me* understand it, and *I'll* help the kids to understand the importance of it." So it's neat to make those connections and suddenly see these scientists go, "Whoa! What I'm doing can be relevant at all levels."

Kathryn is confident about her ability to make science relevant to students' everyday lives. Her job is not to impart content knowledge. She feels that knowing *how* to find the answer and why it is important is far more valuable.

This is reflected in how she teaches preservice teachers. Kathryn has begun teaching a science methods course at a local community college this past year. She said that one of the most important things she can teach them is to "know what they don't know" and "know how to find out". She emphasizes that she is not a content expert and she does not expect them to be.

> So I said, "Yeah, take 'Conceptual Physics.' It's a high school book. It's easy to understand. And then if you need to know something about forces, you read 'Conceptual Physics.' Have it available somewhere." I was trying to talk to them about the available resources that they could have. That they didn't have to know it all, but they had to know if they didn't know it.

Kathryn's emphasis on "knowing how to find out" is also reflected in how she uses informal science.

Using Informal Science

Field Trip Structure

Kathryn says that at her school, each grade level usually goes on four or five trips a year. She teaches in a very affluent part of town where there is plenty of parent and financial support for trips. This is large number of trips compared to the number that most other schools are allowed.

> The field trips are pretty much decided by grade level, but they have to go through our Campus Leadership Team, because they don't want kids going on the same trip every year. So you submit what five trips you want to go on in a year, and then they look at the budget and look [at] how much money that's going to be, and that's approved by the CLT. But they only try to tell you no on things if it crosses over into somebody else's territory. Then you better have a justification. So we have probably three, at least, grade levels that visit the Nature Center, but they are all doing different things.

Kathryn never mentions money being an issue. And she says that she always has plenty of parents who can accompany the group on field trips. In addition to weekday field trips, Kathryn has also arranged an overnight family field trip to Port Conner almost every year.

***Informal science is an essential <u>resource</u> for teaching science and growing professionally*.**

Kathryn said that in deciding on her use of informal sites, she asks, "What do they have that I can use in my curriculum? It's not really, what is their program? It's more, what do they have?" Her emphasis therefore is on the *resources* that informal science sites provide. She says that in planning some of the bigger science units for her students, she has to do a lot of research. As she said, "That's where a lot of these informal science groups are pretty good. What they've developed are good solid resources." Kathryn specifically defines some of these resources as physical or live objects, in-depth content knowledge by the staff, and on-going research projects and specific exhibits. For example, Kathryn describes a valuable resource of the Nature Center,

> … I guess we were doing the Miller Creek salamander, doing some stuff on them, and that's where I went to the Nature Center, because they have research running. They have that little salamander hotel and all the stuff they are working with there. So you can go talk to them and they can help you out on things.

Kathryn tends to seek out those sites which have the content knowledge that she needs. For example, rather visiting the Children's Museum, she is likely to either make a return visit to the Wildflower Center or contact the native landscape architect there to help her plan her school garden. Kathryn's appreciation of the resources that informal science sites have to offer also reflects on how she approaches teaching science. She enjoys doing the research before she introduces a unit to her students and this is where these informal science sites often come into play for her – even if she decides not to take her students there on a field trip. As she says,

> I think a lot of people don't realize when you do some of these bigger units how much research it takes. When I do one, even when we started doing this pond stuff, I just had to read and read and read and read, because all the microorganisms and macro-organisms… I mean, it's huge!

Kathryn says that she likes to be in charge and plans her trips carefully with the informal education staff. She actively seeks out sites and programs that specifically fit her curriculum needs.

> So you know, the Nature Center, I'm able to use at many, many different levels, because they have a huge variety of programs and they have a huge facility actually. We do a pond unit, which is a required unit in first grade in our district, so it is a natural to go to their pond. Usually I let them do their program. I try to always be sure that I've been there and talked to them and looked at what their program consists of. And I'll tell them about the things I want to emphasize in it. I think that's really important to have communication……. So I luckily enough have worked with all of these facilities enough that I can say, "This is what I'd really like to happen."

Kathryn values good communication with informal education staff. Although she values their educational programs, she views her role as the educator and their main role as the resource provider. As she explains,

> You have to have your objectives in mind of what your kids need out of those trips. I think it's a very valiant effort of the informal science people to try to come up with curriculum. They are [aligning it with the state standards]. I think they are doing all the right stuff, but they don't know what I'm teaching. So that is my job.

This focus on communication also reflects directly on her emphasis on *relationships* built over time. She has met many of these informal educators at professional meetings and conferences, and in her graduate level courses at the university. She has also been going to the sites for many years and so has built a reputation with the staff that way. She feels this has benefited she and her students on many levels.

> For instance, [at] Reynold's Farm, he would let the kids do some things that he wouldn't let some of the other classes do, because he knew them and he knew the control that my teammate and I had. And so he might be more willing to let more kids hold the snake, or he let us go in with the pigs and the hog, and pet the hog.

In planning her trips, Kathryn does not like to use the trips as introductions to topics, but as a culminating activity. She wants them to have a conceptual framework to plug the experience into. So she spends a lot of time preparing them on the topic and the trip so that they get the most out of the experience. For example, at the visit to the Nature Center that I accompanied them on, after the guide introduced the students to a spider, Kathryn prompted them to sing their song about spider body parts that they had already learned. The guide was certainly impressed.

BETTY: INFORMAL SCIENCE IS A <u>TREASURED GIFT</u> FOR HER STUDENTS.

As Betty told me about the many after-school trips she would take with her students to local museums and parks in her big family van, her eyes lit up. She told me about the science center they used to run across the street from their school where they kept saltwater fish, mudpuppies, lizards, hedgehogs and lots of microscopes. She told me about the many popcorn and pickle sales they would do at school during lunch to earn their money for their annual trip to the coast. But due to some recent changes in the district and their own school leadership, Betty has been unable to do some of the things in science that she used to do. Betty thrives on being able to do real hands-on science with her students and while she is saddened by some of these changes, she is optimistic about new opportunities.

Background and Teaching Experience

Betty began her teaching career as a high school biology and chemistry teacher. She taught for one year and then decided that the high school level was not where she wanted to teach. She substitute taught for a few years at various schools including Westside Elementary. The principal at that time encouraged her to get her elementary teaching certification and to teach at Westside – which she did. She has been there since 1987. She has taught second grade through fifth grade. I interviewed Betty first in the fall of 1999 when she was teaching fifth grade as part of a pilot study for my dissertation and then again in the spring of 2001 when she had moved to teaching fifth grade math/science.

Betty says she is the “weird bird” at her school because she tends to focus on science. She says that most elementary teachers tend to be language arts focused. She was fortunate in that when she first started teaching, she had a very supportive principal who encouraged her to continue using informal science and staying involved in community projects. As she explains, “She really was good in that she gave us a lot of freedom. She believed in us.”

Betty has always had a love for science and she attributes this to the influence of watching her mother work as a nurse,

> I had hands-on science because I got it from my mother. I followed her around the hospital. And when she became a lab technician and an x-ray technician, I followed her into that lab and I sat at that microscope and she would count red blood cells and she taught me how to do it. I learned how

> to use the microscope – and when you learn to use the microscope, you know – it opens up a whole world!

Betty also says that growing up in the country with science all around had a big impact. This is when she developed a special appreciation for biology. She remembers the joy she had in dissecting a frog in high school and was hoping to become a doctor once she went to college. She says,

> I was going medical. Med tech at the very least and in the back of my mind I was thinking, "Hmmm. I really would like to be a doctor." But then, at our age, it really wasn't the thing to do. You did those things, but what you were really supposed to do was to get married and have children. That's what I did. I did the traditional thing.

When Betty began teaching after having her own children, she brought with her a love of science and a new understanding of children that she says she gained by being a mother. Her understanding of how children learn and what influences them has inspired her teaching in many ways– from her reaching out to the parents of her students to her use of informal science.

Teaching as "Missionary Work"

Westside Elementary is an older, small school with a high number of students from low-income families. It is a traditionally low-performing school with many at-risk students. The student population is largely Hispanic and the school is located adjacent to a community housing project. Yet, the school's population is in stark contrast to the surrounding neighborhood – which is quickly changing as more upper middle class families with young children move in. And yet these parents are not sending their children to Westside. As I drove through the neighborhood to the school, I noticed how eclectic it looked. There were older houses in need of repair adjacent to newly renovated homes. The mix of income levels was apparent. The neighborhood was obviously in the midst of change.

One of Betty's major concerns is the fact that the district has decided to temporarily house the alternative school – which is a school for those students that need extra attention – at Westside the next year. This is not good news for the parents and faculty at Westside who are already trying to pull in the newer families moving into the neighborhood. She feels that the school will surely close down and the district will sell that property, which is highly valuable. Betty spends a great deal of time talking about not only the changes that are occurring at her school, but about her deep concern for the children and families that are a part of Westside.

The school has always been a close-knit community where many of the teachers have gone "above and beyond" the traditional role of teacher. Betty will often hold parent-teacher conferences in the students' homes because, as Betty says, "We know that the best way to help children is to help their parents." So Betty has always reached out to the parents of her students instead of waiting for them to come to her. She says that teaching at a school like Westside with so many "at risk" students is not attractive to most teachers.

> Now putting a new teacher in a school like that who doesn't want to be in a school like that is what's hard – because you have to want to do that. There has to be something inside of you that wants to do that – because otherwise you're going to move onto another school. You're going to say, "I didn't get into teaching to do this. I got into teaching to be a teacher." And I hear that all the time at Westside. And yet I still see the teachers going on, and they'll go out and they'll buy the coats and they'll be sure the kids get shoes – you know, they'll do those things because it needs to

> be done. And because you get something out of that. You get a lot of rewards that way.

Betty says that she was drawn to Westside because there was such a “huge need”. She knows it is probably much easier to teach at a school where there is plenty of money and parent support, and the students are not as likely to deal with such monumental issues such as working to support their family or worrying about language and cultural barriers . But she says that this work is rewarding. She talked about driving students home just so that she can hold parent-teacher conferences on their front steps because there is nowhere else the parent feels comfortable. She also talks about having students stay with her for a weekend when they have needed help, or the many times she has brought in the school counselor to help students when they have confided in her. The school as a whole has funding from several grants, which have allowed it to function more as a community center than a school, so that families can go there for help. Betty explains this.

> And if you’ve been at Westside a long time, you know the families. And the families come to know you and they learn to trust you. So if they need clothes, if they get their electricity turned off, they call the school. I think they look to us for help. We do try to help as much as we can. We do more than just provide an education.

Teaching at a low-income school brings with it many concerns that teachers at schools in higher income areas seldom worry about. Betty says that at school like Westside, the pressure to pass the state’s standardized tests is strong. Their students are already at a disadvantage and need extra help in basic reading and math, so Betty feels that as a teacher, she has to deliberately bring in science or it just doesn’t get taught. And she knows how valuable hands-on science is.

> And if you don’t expose children to something like a microscope when they’re young, they are going to go into science and say, “Science – boring! I don’t want to take science and it’s hard and I have to do math. I don’t want it.” But if in elementary school they’ve been exposed to microscopes and all these neat things, then they’ll say, “Oh, that’s fun. It’s worth it. It’s worth maybe me studying a little harder.”

One of the ways Betty has brought science to her students includes the Mystery Project, which was an interdisciplinary program that connected low-income schools from across the country in solving science mysteries. She was one of the first teachers to participate in this program. She was also one of the first teachers involved with EarthWise Camp, which is a community-based science curriculum developed by the City of Jonestown and implemented in Jonestown schools. The emphasis is on both taking the students into the community and on bringing the community into the classroom by connecting teachers with valuable resources. Betty has also worked on several projects with the Nature Center, and when she had smaller class sizes, she would regularly take her students down to the local creek to do regular science surveys and water testing. Betty has also managed to take her students to Port Conner every year to study marine life and has recently begun the science fair again at her school.

Up until just a few years ago, Betty and her students used to run a science center across the street in a little house that belonged to the school. She describes this.

> The front room was a microscope room and the back room was animals. And I just started out with the things I had in my classroom and pretty soon we turned into the facility where we were taking in animals that had been hurt and abused. And we were working with all sorts of people here in the city. When they had an iguana, for example, that needed a home,

> they would call us and we would take it in and the kids would take care of him.

She says that they would also bring in animals from their trip to the coast and they set up saltwater tanks. The science center was something the entire school benefited from and her students took particular pride in. She says that she felt the science center gave these students something they could not get at home.

> Realize, at Westside, most of the kids at Westside, or a lot of the kids at Westside, can't have animals. If you're in a housing project, they do not allow pets. No dogs, no cats. So we gave them that.

Eventually, it got too much for her and her students to take care of alone, so the school hired her son to take care of it part-time. This worked well until that particular principal left and a new principal came in who did not plan on focusing on science. Betty says that they just recently gave away their last few animals. Betty sadly said that science has since taken "a back seat to everything else."

Betty wishes that she could bring more inquiry science to her students – like she used to when there wasn't the test pressure and she had smaller classes. Yet even when many students in other classrooms are not getting science at all, she still makes time for hands-on science at least once a week. She knows that this is not enough.

> My challenge as a teacher is the time that it takes to do science – hands-on science and the time that they are demanding of us to put into balanced literacy, for example. It's just really hard to do. A lot of us are looking at block schedules so that we take that maybe 1 or 2 days a week and we say these are our science/social studies days. And the other days are nothing but reading and math.

Using Informal Science

Field Trip Structure

At Betty's school, each grade level is allotted one bus trip a year. Betty says that her grade level has usually gone to the Nature Center's Aquifer Exhibit because it fits well into their curriculum on land forms. If Betty is to take her class on any other trips, they have to earn the money themselves or get involved in a funded project. Every year, Betty and her students have raised the money to go on their Port Conner trip. She has also been involved in two funded projects which have allowed her students to go on more field trips – a national contest with the Nature Center on school-community science projects funded by AAAS and EarthWise Camp funded through the City of Jonestown.

Informal science is a treasured gift for her students.

When Betty talks about the local museums and parks, she emphasizes how inherently valuable they are to her. They are places where students can meet with scientists, learn about animals by observing them and go for walks through nature preserves. She has enjoyed these places simply for their unique value for many years with her own family and wants to make sure that her students are allowed that same opportunity.

> That's what I had done with my biological children. I knew how much they had gotten out of it. So when I started teaching, I took them to all these things because it felt right. Because I knew it's what they needed.

Betty says that she feels that all children need and deserve experiences beyond the classroom. She realizes that reading or telling them about science simply is not enough. She uses informal science because she believes her students need more than just what she has to say. Betty feels that she is not allowing them to experience “real science” if they do not get to actually see it in the community. This is where informal science sites come in. As she explains,

> We’re not just giving them fundamentals, we’re really showing them what’s out there – what they can really do, what they can aim for. In the classroom, we can teach them science but they don’t see a scientist at work. With these programs, we can get hooked up with scientists actually at work and the kids can see what they actually do and that can really turn a child on.

Betty also recognizes that in order for children to feel that they themselves can be scientists, they must develop both a love of science and a belief that science is for them too. After having her own children, and taking them to many museums and parks, she realized the value of this. And she is concerned because most of her students’ will never visit a museum or zoo with their parents. It is therefore important to her to expose them to the possibilities. She expresses how she is capable of making these informal science experiences relevant to her students. It is not so much about the actual site to Betty, but the fact that her students are learning about the community of science and the opportunities that exist for them.

> What a child chooses to do depends a lot on what you’ve exposed them to when they’re little. And it’s not necessarily going to come out of what they’re exposed to in the schools. I found out that generally that’s not the case. It’s these other outside things that you expose them to that’s so important. So, I guess the parents don’t do it so I feel like I have to do it as a teacher.

She obviously sees herself not only as their classroom teacher, but as a kind of parent as well. This goes back to her view of her job as “missionary work”. She cares deeply about the futures of her students and wants to make sure they get every opportunity that the students at the more affluent schools are allowed.

Because her students are less likely to travel or visit local informal sites with their parents, Betty sees it as even *more* important that she be the one to instigate these trips. For this reason, she has worked hard to make sure that they at least get to go to the Texas coast every year for a weekend trip. This is outside of the allotted one bus trip a year budget, so the students have earned their own money by selling popcorn and pickles at lunch, having bake sales in the mornings or selling candy. Betty has worked to get good deals on rental vans. And they have done things like camp out or stay at a family friend's condominium to save money. They have always participated in the program at the university's marine science institute and then gone to the Port Conner Aquarium, as well. While earning the money has always been an issue, there have been a few times where the school has had some grant money that helped with the trip. This happened when Julie was principal and there was much more support for science. Betty says that while the principal following Julie was not at all supportive of science, the new one they have now is excited about the trip and wants to support Betty in making sure that it happens again.

Betty has gone to great lengths to make sure that her students experience the excitement of visiting the coast, but she says that it is not easy. Her field trips are limited by a lack of adequate funding and for this reason she has often sought out projects like the AAAS Contest with the Nature Center and EarthWise Camp, where transportation is provided. She explains her motivations for taking them to the coast every year despite her limitations.

> A lot of what we get to do, if the transportation is provided, we get to do it. If the transportation is not provided, we don't get to do it. That is the case. Absolutely. Unless you have a teacher that has a passion for something. My passion was getting the kids to the ocean. I really wanted them to know what an ocean was.

The *passion* is the key and that is what has motivated her to spend much of her own money on taking her "Westside Explorers" all over town visiting museums and parks after school.

> I used to do a lot of after school stuff, in fact, every day almost. We took kids. I used my van at the beginning. I had a big old van that I'd use for my own children. I used my van and we took kids all over Jonestown. We did a lot of Nature Center stuff. It was fun.

Betty says that now, unfortunately, most of the students' after school time is spent on test preparation. And she herself spends many afternoons on test tutoring. But while the emphasis at her school has not been on science recently, she did say that the community programs at Westside are going well and that on some afternoons, parents will come up and lead arts and crafts classes with the students. Yet she is saddened that more afternoons are not spent on science and she is hopeful that this might change with their new principal's support.

During our last interview, Betty said that she was excited about some new opportunities for the upcoming school year. Her principal wants to get their teachers trained in one of the nationally recognized marine education curriculums and also plans to send Betty to a special training session for teachers at a local outdoor informal science education site. She would then take her students to this site in the spring for a fifth grade curriculum unit. Betty was also very happy with the way her coast trip went and said that she wanted to do it earlier in the year so that she could start off the year on a good note with the parents. She said that she took a lot of parents, most of them had never been to the coast, and that they loved it as much as the students did. So, while Betty waits to see what the next year will bring for the future of her school, she sees promise in that she may be more supported in her efforts to bring "real science" to her students. As she says, "You know, I feel a lot more excited about teaching now, too, just knowing that the possibility of these things exist."

GREG: INFORMAL SCIENCE SITES ARE SCIENCE LABORATORIES FOR HIS CLASS PROJECTS.

As I sat in front of the Nature Center waiting for Greg and his fifth and sixth grade class, the Garza Young Scientists, I heard laughter and the sound of people running. I then saw a group of students in matching blue shirts come bounding down the stairs. They were late. A few students carried some collecting kits and others were carrying notepads. Their teacher followed them, and the students were breathing hard and laughing from their sprint. Lisa, the education director at the Nature Center greeted them and led them back through the trails to one of the education rooms. The students knew that they had a task to accomplish that day and they listened as their teacher coached them on insect identification. They appeared prepared and knew what to expect. They had done this before. Lisa split them into groups and each group had a kit with collecting equipment and a notepad for recording what they found. They then went out to pre-identified locations around the pond where they had previously set out leaf bags to serve as habitat for aquatic animals. They began collecting data, such as water temperature, turbidity, and pH. They then sorted through leaf bags and began searching for aquatic animals that they then identified using a guide and with the help of Nature Center staff and their teacher. Many of the sixth graders were more familiar with this and they took the lead for the group, helping the others to identify the animals. It was the beginning of spring, and so insect larvae, and snails were abundant. Some of the students noticed new animals and were excited about the find. I walked over to one group and a focused young girl kept her eyes on the dish of aquatic animals she had found. She enthusiastically showed me each and everyone. “These are blood worms. But what are these? They don’t look like the picture?” “Hey guys! Get over here!” She shouted to her teammates. But they were busy watching two turtles sunning on a nearby log. As I left that day, I thought how fortunate these students were. I did not study the macroinvertebrates of ponds until I was a senior in college and didn’t learn to appreciate them until then. These students have an enthusiastic teacher with a particular passion for science and for making sure his students actively participate in science – not just passively experience it.

Background and Teaching Experience

Greg teaches a class of fifth and sixth graders at Garza Elementary, which serves low-income Hispanic families – many of which are below the poverty line. Most of the students live in one of two government housing projects adjacent to the school. Greg has been teaching for fourteen years, all of which have been at Garza. He has taught fourth grade, fifth grade and sixth grade. I interviewed Greg first in the fall of 1999 for my dissertation pilot study and then again in the spring of 2001.

Greg has a degree in Russian and Russian Literature, is certified in elementary education, and has a M.Ed. in Science Education. Yet, Greg came into teaching a little later in his life. Greg was a Russian major in college in South Dakota and his pursuit of a graduate degree led him to Texas. He worked in construction and then spent 10 years as a medical technologist. It was then that he said he “got the fire” to teach. Greg says that he began having “fantasies about teaching” and decided to earn his teaching degree. He says that although he never really acknowledged his desire to teach before, he could see how it had always been there. He was in the Future Teachers Club in high school and had always had a strong desire to help people. It was this desire, he believes, that led him to his first teaching job, which was at Garza. His first years, though, were rough and he was challenged both mentally and emotionally. He was surprised at how violent the students’ were towards each other.

> If you’ve seen one of those programs or made-for T.V. movies about inner city kids… This is it. That was it. And not the cool ones in high school that kind of have the game figured out. But younger where it is raw and it is offensive. Done totally out of ignorance. And they’re talking out of their parents ugly mouths. The kids don’t even know what they are saying, really. Just hurting, ugliness.

The discipline problems interfered greatly with his teaching and the students were not learning. After some intensive workshops on discipline, and a few more years of experience, he was able to better control his classroom. He chose not to let student misconduct interfere with teaching and learning. But he also had to make sure the students knew that he sincerely cared about them. He says that in order to be effective as a teacher, you also have to be sensitive.

> If you are insensitive to kids, you will never be effective, no matter what kind of pedagogical skills you have. It's the sensitivity that breaks down the barriers between you and the students. They know that you care. It's the emotional bonding and connection that's made. The only way to do that is to take your armor off, and once you take your armor off, you can be injured. And as a teacher, you are extremely vulnerable.

This sensitivity requires going beyond the normal job descriptions of a teacher. In Greg's case, he sees that it his job to "turn the students on to learning. Because in the particular community in which I work, there is a definite tendency of the students to be turned off to school." He says "If I allow students to pass through my room without realizing the importance of education for themselves and the world, I have not done my job".

Yet Greg soon realized that in order for his students to be "turned on" to learning, he had to find ways to make learning relevant to their own lives. They needed something more so that they would really "get it". It was during this time where he was searching for a solution, that he became involved in two university programs aimed at enhancing teachers' use of hands-on science activities so that students could learn by doing. Greg says that the effect of these programs on his teaching was "immediate and productive". His enthusiasm increased dramatically and he noticed this also had a positive affect on the students. He noticed that they were much more interested in the activities and that classroom management was less of an issue because they were actively doing something that interested them.

Greg says that he has realized how engaging science can be for all students, but especially for his at-risk students. He describes one lesson that really made a difference for one particular student.

> One lesson was about gears and pulleys and I brought a bike in. We talked about what was happening there and why this gear is bigger than that one and when you change gears the size of the pulley is so important on how easy or difficult it is to move the pedals and things like that. I had a special ed. kid who really couldn't even write letters. But, he couldn't get enough of that. He worked on bikes all the time and it really clicked with him because he could relate it to a physical experience. I just realized what an engaging tool that is even if it's not your whole curriculum. If you can give kids something that they look forward to – to do. That's what I use science as – really as a hook.

The Garza Young Scientists

It was at this point in his teaching career, that an amazing opportunity presented itself. Someone from the Science and Technology Center at the local university called the principal at Garza looking for a classroom to adopt. They were beginning an outreach program to get more minority students to enter into science-related fields. The principal at Garza referred Greg because he was known to be the teacher doing a lot of science. Greg and his class began by first taking field trips to the university to visit with scientists and see lab demonstrations. The Science and Technology Center then purchased some science equipment for Greg's classroom. They also had regular graduate student mentors come and visit their classroom. As Greg says, "The students began to see themselves as scientists, as much from the activities in the classroom as the company they were keeping".

Greg soon realized that if they really wanted their students to go into math and science, then they needed to have the opportunity to go the science magnet school – Griffin Middle School. Yet, Griffin started at 7th grade, and Garza stopped at fifth grade. It would be difficult to accomplish this goal without creating a special sixth grade class at Garza. So along with the help on a community-based nonprofit group, Jonestown Interfaith, Greg and the outreach coordinator from the university were able to make this happen. While most of the sixth graders went to on to the local middle school, some students were selected to remain at Garza in Greg's special class. The students submitted applications to be considered for entrance into this special program. Greg has had 30 to 40% of his students every year go to the science magnet school. Before the Young Scientist Program, only one student had ever attended this school from Garza. Greg's class has recently been transformed into a fifth and sixth grade program because all of the sixth graders are now kept at Garza. Greg says that they decided to make it a multi-grade level program because they did not want to take all of the top students out of the other sixth grade classes.

The Young Scientist Program has grown in Jonestown since it first started ten years ago at Garza. There are now seven of these programs at different schools. The funding no longer comes from the university's Science and Technology Center because their grant expired. So Greg and his class were connected with the Nature Center Guild, which has been sponsoring Greg's classroom until just recently. This is how they became partners with the Nature Center. The Garza Young Scientists have been doing pond studies at the Nature

Center and visit there many times throughout the year – sometimes once every other week while they are collecting data.

During our last interview, Greg and his students had just finished their live on-line presentation of their group's project in a nationwide contest sponsored by the American Academy for the Advancement of Science (AAAS). In partnership with the Nature Center, they competed for the 2001 Prize for Online Science Education which was part of International Public Science Day. They worked very hard on this project, which included a web page detailing their work with macroinvertebrates at the Nature Center's pond, point-to-point videoconferencing with other Young Scientists schools in Jonestown and then the live on-line broadcast presentation. This entry into the contest came out of the grant that the Nature Center had received from AAAS for a technology-based collaborative project with a classroom. Greg describes the live online presentation skit that his students had prepared.

> We had an introduction where someone said, "Welcome to Garza Elementary in Jonestown Texas" and "we're glad to give you a presentation on some of things we have learned in our study at the Nature Center." Then the kids said "Oh! Look there! What is that?" And they all start pointing and we look down and there is one of our bug models on the floor. And everyone started screaming and somebody said, "Hey. That looks familiar. Doesn't that look like something we saw at the Nature Center?" And somebody says, "Hey, yea! It does." And somebody else says, "Well, let's go to our website and see if we can figure out what it is." We had that Bug I.D. thing on there. So then the camera turned around and showed the computer which was logged into the website with the [identification] key on it. So, somebody said, "Does it have legs?" And they would say, "Yea!" And then, "Does it have wings?" And then, "Yea." "Does it have gills?" "Yea!" So we follow the key through and then everybody goes, "What is it?" "It's a stonefly larvae!" We went through five of them that way.

This contest went beyond just the immediate attention and prize money that Greg's group and the Nature Center would receive. Greg felt that it would add credibility to the Young Scientist Program. It has had so much success, and he did not want to see the district lose interest in supporting it. Greg explains this.

> If we win, we'll get the national attention – coming out of Washington. And I want to be able to say, "Yes, this is a cooperative experience between the Young Scientists Schools. The Young Scientists Schools are an initiative to get more minority kids into science….." You know, that's the big purpose. If we make enough hoorah about our program then they won't be able to take it out of the schools. And if we don't, then they can do what they want. That's the deal.

Greg had put a lot of energy and after-school hours into preparing for this contest and he really believed that they had a good chance to win. Although they did not win the grand prize, they did get Runner-Up. He says that he knows they had done the best they could, and the students definitely feel a sense of accomplishment.

Greg is very proud of his Young Scientists discusses the history of the program and the details of their projects with great enthusiasm. Not only have his students benefited, but so has the school and surrounding community as well. He says that their expectations have been raised and the students in the Young Scientist Program are admired. Greg has a poster in his classroom that he referred to when describing the effect that this program has had on the community. It reads, "A mind when stretched to a new idea never goes back to its original dimensions." He says,

> That's sort of like a community's expectations that when stretched to a new point will never go back. Now it's gone from a dream to an

> expectation. It's gone from a vague possibility to a reality. We have kids over there. Kids can make it.

Using Informal Science

Field Trip Structure

Greg's field trips vary depending on what projects Greg's class is working on that year. In the first years of the Young Scientist Program, they would go to the university often to visit with scientists and tour labs. Since their association with the Nature Center, they have most of their time over there. They may go seven to ten times a year. This had been funded by the Nature Center Guild and the AAAS grant that the Nature Center had been awarded. In conjunction with the trips to the Nature Center, they have also gone on a weekend trip where they visited the university's Marine Science Institute in Port Conner, the Port Conner Aquarium and Hearst Gardens. The school and district limitations on field trips do not really apply to his classroom since they are funded through outside grant money.

Informal science sites are science <u>laboratories</u> for his class projects.

Greg uses the resources of informal science sites as tools to accomplish his classroom goals. Greg described his role as teacher as "facilitator" and he strives to make science learning interesting and relevant. He does this mainly through student-centered class projects. When asked his reasons for using informal science, Greg responded,

> I am using them [Nature Center] because they are just like a laboratory to me. We don't go there and they put on programs for us. We go there to use their site because they have this water facility.

Greg is very much focused on *how* he uses informal science, as opposed to *why*. He spends much of the time talking about his class projects. Yet, these projects all are based on the partnership with the Nature Center. He has developed an excellent working partnership with the staff there and he and his students feel as though it is their "own backyard". The education director has visited their classroom on many occasions and worked closely with Greg. Yet, he is definitely always in charge – even when at the Nature Center. When I observed them collecting data at the pond, he and the education director both spoke to the group and he did not turn them over to the Nature Center staff once they arrived. In fact, on many occasions, they visit the site and do not have any staff assistance.

Greg is clear on why is using the Nature Center with his students. It is simply because the Nature Center Guild had sponsored his program. He says that, "I would not have thought of involvement to this degree if it was not for the sponsorship. I would not have dreamed of asking so much of their time if we had not had a special relationship." Because the money and expertise to handle this partnership was present at the Nature Center, that is where his class ended up.

Having his students out working on real projects in conjunction with scientists is what matters most to Greg, not necessarily the location. In fact, before the Young Scientists Program, Greg was not necessarily a regular user of informal science. And yet, it was still important for him to provide his students with opportunities for hands-on science outside of the classroom. Before the university and the Nature Center due to the Young Scientists Program, Greg says that he would take his fourth graders down to a nearby creek sometimes every other week. They would look at the plants and animals but he said it was not anything real organized. He thought it was important to just get them down there so that they could appreciate it. Greg also says they would walk to the lake, which is only eight or nine blocks away. He did say that he applied for a small grant at one time and was able to get some water quality testing kits, which he still has.

Greg's emphasis on exposing his students to hands-on science experiences reflects his educational philosophy. He states,

> I believe that it is human nature to problem solve and inquire into all phenomena of the universe. We, as teachers, do not need to teach problem-solving and inquiry as much as we have to revitalize and reestablish it in the student's life.

Greg says that in the community he works in, the students have been especially desensitized to their creativity and inquiry skills and many of the most gifted students rely heavily on their past success on worksheets and rote memorization. He says that many of them resist at first the kinds of hands-on learning that he re-introduces them to.

> We have a profile of these potentially high achieving children. When I get them, they're not used to doing anywhere near their best because they have never had to. They're not interested in doing things particularly that you would picture a GT kid doing…because that's scary. They want that old worksheet. That old worksheet's been getting them hundreds. "Don't give me open ended…you know, my kind of creative thinking kinds of things because I don't know if I can be successful at that." And that's really the typical profile.

For his students, visiting with university professors in their labs or sorting through leaf bags at a pond site is something entirely new to them. All of this helps them to realize that they are capable of thinking like scientists too, and more importantly, that they can be scientists. And as Greg said, "It's a research fact that kids who have contact with a scientist - it's a high predictor for them going into the field of science. [Before this] they didn't know anybody in science".

This is where the informal science experiences play a big role for these students. According to Greg, they suddenly realize that they are comfortable in the world of scientists and real science, because that is what they have been doing. Greg encourages them to work together and come up with their own solutions. And he is comfortable with not always having the answers. For example, on one occasion, they were out at the Nature Center's pond taking depth measurements for the contour map they were creating. They were doing it in a grid-like fashion to try to be as consistent as possible. But the paddle boats they were in were difficult to maneuver, especially backing up so they weren't hitting their mark. They kept moving from their target spot. He says at first they were just getting angry and then they just couldn't stop laughing. So they then came up with an idea of using two boats to more accurately maneuver. Greg describes what happened.

> We came up with the greatest system. This boat can move it this way and this boat can move it this way. You've got a system! So when you need to move that way you use this boat and if you need to go this way you use this boat. And when you need to go this way, you both move. It's awesome. It's always a vector, you know. You have all the vectors covered. So it's just a combination – "you go back a little bit and we'll go forward a lot." I was tickled!

Greg and his students do not only use the Nature Center for their own class projects. Greg explains that they also want to give something back to the Nature Center. So they have worked to develop a new contour map of the pond on site, a brochure on the animals around the pond, and they bought a weather station that is connected to a computer to be housed permanently at the Nature Center. He says that the Nature Center also benefits directly from this relationship and the students feel they are working on something that other people will benefit from.

With the Young Scientists Program, Greg has clearly had a positive impact on the Hispanic community in which he works. His dedication to the students and his drive to always improve his teaching has demonstrated how he has "stretched minds" in many ways.

SUZANNE: INFORMAL SCIENCE IS THE BRIDGE TO THE WORLD FOR HER STUDENTS.

As I walk into Suzanne's kindergarten classroom, I immediately notice the emphasis she places on science. It is a room filled with boxes of animal bones, different kinds of rocks, and lots of animals. She has goldfish, tiger salamanders, hermit crabs and a tarantula. She also has a guinea pig and usually has at least one snake. At other times she has had lizards, turtles, rats and even chickens. Suzanne also has a little blue pool filled with salt water and plastic marine animals. She says the students pretend that they are in a lobster fishing boat or scientists in a marine research laboratory. She also gets out masks and microscopes so that they can really have fun with it. Most kindergarten classrooms have plenty of hands-on learning going on, but this classroom has something else as well. It gave me the feeling that the natural world is truly appreciated and studied there.

Background and Teaching Experience

Suzanne has taught kindergarten for 24 years. She began teaching in Jonestown in 1974 after completing her degree in education; and in 1978, she received her masters degree. She then left teaching for three years and traveled to Tanzania, Africa where she and her husband started a photographic safari company. Suzanne then came back to Jonestown and taught until 1989, when she got a divorce and moved out to Lake Evans – which is close to Jonestown. She taught at Lake Evans Elementary for ten years; and she has now been teaching at Jemison Elementary since 1999. Moving to teaching outside of Jonestown has been quite a change for Suzanne. She used to teach on the east side of Jonestown, which is low-income and high minority. It is a big district and the schools she worked in had strong ties to the university, which allowed for the steady influx of new ideas. Suzanne says that the district she teaches in now is much smaller and there are far fewer minorities. The income level of the families is much higher as well. This change has affected many aspects of Suzanne's teaching, which will be described later.

Suzanne is undoubtedly science focused. She said that she "has a reputation as the science teacher", and that her curriculum "runs on science." She traces her love of science back to her father who was a research mammalogist. Suzanne says that she, more often than her other four siblings, accompanied her father on many research trips. She says that, "I didn't know that life could be anything but going out to look for turkeys with my dad." Her father also went to Africa to research wildebeests. She spent a month with her parents when they were living on the Serengeti and fell in love with it; and that is the reason for her traveling back there a few years later. She says that she really built up her science knowledge while running her photographic safari company and that if she had to do it over again, she would probably have gone into the biological sciences as a profession.

Science Emphasis and Suzanne's Curriculum

When Suzanne first moved to Lake Evans, she says that teaching science was of low priority compared to what she had been experiencing in Jonestown. In fact she was appalled to learn that they were not members of Regional Science and Living Material Center, which only costs 25 cents per student per year and allows them access to all kinds of wonderful resources. She said that in Jonestown, it was never a question. The science teaching encouraged there had been creative, hands-on and very kinesthetic. In contrast, the science done in Lake Evans was, at the time, "pretty boring and pretty babyish." She encountered some initial resistance to her different ideas about teaching science. But Suzanne worked hard to change that and insisted that kindergartners could learn a great deal about science. She says that she knows that all students love science – especially biology – and that it is easy to get them involved in all of learning through science. And reading about science is particularly effective in encouraging them to read. As she says,

> Science is great for that [reading]. The kids connect and they are so excited about words they can read like "metamorphosis" and "echinoderm". I was just teaching echinoderm to my low readers today. It fires them up that they can get information about what they really, really want to know about by reading. And it's a real powerful tool for them and they make that connection really quickly because the content is very heart felt.

Through her classroom animals and many field trips throughout the year, Suzanne makes a point to make science a priority. Her enthusiasm is apparent.

For example, just recently, she brought in a large garden spider and simply put it in the window and asked it to "just build your web." Which it did – over the entire window and the students loved it. They brought in insects and threw them into the web and watched in amazement as she quickly wrapped them up and ate them. Suzanne had it up the whole spring and took the egg sac home. She is waiting to see if she can get the babies to hatch.

Suzanne describes her students' and her own excitement about doing activities like this.

> Kids just love stuff like that. They just love it. And it's what makes me feel good about teaching. If I couldn't do those things, I'd go crazy. But my room usually stinks!

Not only does Suzanne teach with a science emphasis, but she and a partner have written an entire kindergarten curriculum, called "Pals", that has recently been published. It is a multi-disciplinary curriculum based on the letters of the alphabet. There are 26 books and each letter has a themed character that is environmentally based. It took Suzanne and her partner over six years to write it. They first had the idea to create it after they had been using another somewhat similar curriculum that, as Suzanne says, had "dumb characters" like M for the Munching Mouse. She knew that she could expect more from her kindergartners. Some of the characters include G – Golda the Global Gardener, C – Carlos the Cactus, and M – Monica the Monarch Butterfly.

Suzanne explains that she realized how many teachers do not like to teach science. She hopes to make this easier by "placing science in teachers' hands in a way that they can really use it." She knows that it is difficult for teachers to gather together materials and look up activities to teach science effectively. So she has put it together for them and in a way that doesn't separate it off from the rest of the day. It can be taught with reading, art, social studies and math. Suzanne acknowledges that science is teachers' "weakest link across the board" and she hopes to help with this problem. As she says,

> There are very few teachers that have any interest in science. Most of them go, "Ooh! Yuck! A bug!" And so I am unusual in that sense. But, I'm hoping that making science friendly with Pals will help that whole process – help teachers become more comfortable and teach it a little more.

Suzanne says that she thinks teachers will like this curriculum because it is "brain-based and backyard-based." These are all things that the students see in their own local environment. It has meaning to them.

> It's just real connective to their real world and we hope – our ardent hope is that it teaches children to be better caretakers of the planet. That's my most ardent hope. And I see that as my role in working with young children – is to build people who have a little bit of awareness about what is going on.

Using Informal Science

Field Trip Structure

Suzanne plans field trips for the entire kindergarten at her school, which includes six classes. They normally go to eight different sites throughout the year. They manage this by combining two trips in one day. The places they typically go include the Children's Museum, the Museum of Science and History, the Wildflower Center, the zoo, the landfill, Reynold's Farm and the art museum.

The school Suzanne teaches at serves families with a relatively high income level and Suzanne first just quietly asked them for money so that they could go on these trips when she first came to Lake Evans. The district was paying for two school bus trips a year. Once the other kindergarten teachers found out about Suzanne's trips, they were very interested and simply wanted to go too. So it was then and everyone started going and they asked the PTO for money for the buses. Suzanne says that for the first few years, she had to write a proposal and present it at a PTO meeting to get approval. She does not have to present anymore because they have simply approved the money; and they have even paid for a larger and larger percentage of the total bus costs (the parents still pay for a part of it). But Suzanne is worried now because there are more kindergarten classes now and they now need two large buses, which costs much more.

Informal science is the <u>bridge</u> to the world for her students.

When Suzanne began teaching, she was working with low-income families on the east side of town. She says that she was very enthusiastic and was there "to help the universe." She and the other teachers would help the families with things like getting food stamps, medical care and library cards. At that point, Suzanne also realized how important it was to get those students out into the community. She said that the district really supported them then in going on field trips and the presence of teacher interns from the university also kept them "fired up" about going the extra mile for the students and their families. Suzanne would take her students to many of the same places she takes her students now but they would also go places like the public library or the tortilla factory nearby. She explains how her focus for these trips has changed with the students she teaches.

> Those kids on the east side almost never went anywhere. And it was almost essential that they be taken out into the community. Now – it's

> kind of a luxury. My focus has kind of changed from basic stuff to content within the study trip. It's more related to what we're studying.

While her focus may have changed somewhat over the years, her basic premise for taking her students on field trips has remained the same. Suzanne says that getting students to feel a part of their community is important in nurturing conscientious citizens.

> How can we feel any community with our planet if we can't feel any community with our community? You feel community with your home, then you feel community with your neighborhood, and then you feel community with your city. And until a child feels a sense of belonging or connection, then there is no urgency to interact, to protect. Be in. Do for. All those things we try to teach kids to do.

Suzanne attributes her interest in field trips to her early teaching environment on the east side of Jonestown where there was an emphasis on education outside of the classroom and more creative science teaching. She says that this may have been due to the fact that it was a turning point in Jonestown's history where it was transitioning into a bigger district and there happened to be some exceptional leaders in place then. She has since made a big difference at not only her own school, but the district, as well, in terms of the amount of field trips the kindergartners take. She also brought with her a more challenging science curriculum for her students, and many of the other teachers are making use of this too.

Suzanne emphasizes how essential it is that the field trips she takes are directly connected to her classroom curriculum. She links her "letter pals" (from her curriculum) to her field trips so that the students have already had a unit of study around these concepts. For example, the students had already studied world hunger, agriculture and overgrazing centered around the “letter pal G” which is Golda the Global Gardener, before they visited the Wildflower Center.

Suzanne takes an active role in preparing her students for these trips to make sure they are well-prepared and eager to learn once they get there. She explains this process.

> I love prepping for study trips. They always have a good knowledge of the concept that we’ll be covering. Like with the Wildflower Center, we had studied dandelions, yuccas and sequoias. We had all of these examples of species that sort of segued us into a study of plants in general. So they have a unit about the topic under their belt. Then we do intensive pre-site specific study. I show them pictures of where we’re going. I walk them through the whole sequence of events. I get them to predict what it is they’re going to see. I get them to elaborate on that prediction. We do lots of language in the pre-prep program.

She also makes sure that her students connect what they saw with what they have been doing in the classroom. She says they really go back and “process” by drawing pictures, telling stories, and doing experience charts. Suzanne says that while post-trip activities are important, the pre-trip preparation is more important because it gets them eager to learn and they are better able to process what they are experience rather than just being overwhelmed by it all.

While Suzanne appears to have succeeded in terms of wining the support of her fellow teachers, principal and parents for these many field trips, she has had to pay the price of being the one to “make it happen”. She is the person who makes all of the arrangements for the entire kindergarten to go on these trips. She has even asked the other teachers if they have wanted to take the job over, but there have been no volunteers. She says,

> People don't want to mess with it. It's a lot of trouble. It takes a lot to organize. It takes me a lot of time to make all of those calls. And then you've got to call them back and then you have to be sure you can get there. But it's so worth it.

She also says that many of the upper-grade teachers are somewhat resentful that she takes so many trips and claim that they cannot go on them because the students have already been on these when they were in kindergarten. Suzanne believes that this is a ridiculous argument. She explains why,

> I hear it all the time. "We can't go there because you went there." I just say, "No. The brain of a kindergartner is much different than a brain of a fourth grader. You've got different things to look at. You can do ten times the things we can do." It's almost so stupid because you can't argue about it. I just get furious.

Suzanne teaches in a small district and is therefore more strongly influenced by district level decisions that the other teachers. She also does not have a very supportive superintendent in terms of her focus on science and she worries that with the increasing cost of field trips and the negativity from some of the other teachers, that her field trips may be reduced. Suzanne explains that her superintendent is not science-oriented and therefore does not actively encourage science teaching, nor does she support science-based field trips. Yet, luckily she has a supportive principal, parents and fellow kindergarten teachers. The Parent Teacher Organization is very supportive of her trips right now and she is grateful that they are supplying the extra funds for her trips. She says,

> If there was anybody – in any of the kindergarten team leader positions – who was feeling pressure to go on [field trips] because everyone else was – we'd get in trouble. We can stand in a united front now because we all know that community- based education is crucial to children's learning and outlook.

Suzanne has remained steadfast in her refusal to let go of her field trips, even if that has meant much more work for her. It is a part of how she teaches and she can't imagine teaching any other way. It is part of who she is. She says, "And I tell you, a lot of my motivation is just for my own pleasure and satisfaction. I enjoy that a lot. You know – you just do what you enjoy."

VICKI: INFORMAL SCIENCE EXPERIENCE GAVE HER A STRATEGY FOR TEACHING SCIENCE.

As I sit inside the lobby of the Museum of Science and History waiting for Vicki and the rest of the third grade classes from Cooper Elementary, I notice how late it is getting. Her tour was scheduled for 11:30 and it is now almost 12:00. They have lost their tour guide (they allow them only 10 minutes) and I know they will be rushed. At 12:00, I finally see the buses arrive and the kids then sprinting up the steps to the museum. The teachers divide the entire group into two, and Vicki's class goes to a grassy area to eat their lunch while the other group goes inside. The students are excited and have trouble sitting still to eat. Before going into the museum, Vicki shows her students the giant dinosaur tracks that are encased near the picnic area and the students marvel at how old they are.

Vicki said that she had planned on focusing on the Texas wildlife exhibit area and had hoped the museum would send her those materials, but they apparently sent her the prehistoric life exhibit information instead. And now without a tour guide, she was left to guide the students on her own. She first let them explore the Great Hall of the museum on their own while some of the students went to the gift shop. I have already noticed a few students who are already asking many questions and are more focused as they look at the exhibits.

Many of the others though are a little harder to control and can't seem to pause long enough to learn anything. Vicki soon gathers them together and takes them upstairs to the wildlife exhibit area. It is then that she makes a point to lead them through and remind them of things they have studied in class. Unfortunately, there is only one other parent with her class and she has trouble with keeping some of them focused. Once she sits them down in front of one large exhibit and talks to them about it, they seem to be more interested and begin paying more attention. They are especially interested in the fact that the animals were alive at one time. Vicki then moves them through more exhibits and they are then reading more and listening to her explanations more. She makes a point to highlight terms they have studied in class, such as nocturnal and vertebrate.

As we move through the museum, I notice that although the students do not seem extremely prepared for this trip, they have a teacher who is interested in the material and takes charge. The other two teachers appear comfortable letting Vicki take the lead and do not actively guide their students through the museum as she does. Vicki looks a bit exhausted as they load the bus after dealing with discipline issues inside of a very old museum with bad acoustics. But she appears pleased as she witnesses the excitement on her students' faces and answers last minute questions as they leave the museum.

Background and Teaching Experience

Vicki has been teaching for 17 years and at the time she was teaching third grade at Cooper Elementary in Jonestown – which is a brand new school. Previous to this, she taught third and fourth grades at Fisher Elementary, also in

Jonestown. She says that both schools have a very diverse student population in terms of ethnicity and financial levels, but she says that there is not as high a financial level as there is at Pease.

Vicki majored in education and minored in history. She is also certified as an English as a Second Language (ESL) teacher. She says that up through her elementary school years, she did not excel in school and only did what she needed to "get by". But it was a history teacher in middle school that turned her on to school and eventually to teaching as a profession. He modeled a way of teaching that she would strive to create in her own classroom many years later. She describes this experience:

> In walked a short, red headed teacher who had a quick wit and outgoing personality. He made history come alive. He got everyone involved in projects, skits, and reenactments of famous events. We read first-hand historical accounts and novels which helped us understand the people of the times we studied. He did not allow passive listening in class. I could no longer hide books under my desk and turn out. Everyone in class had a job to to complete, be it script writer, editor, set designer or information gatherer. Each lesson related to the one before it leading us on a wonderful adventure through time.

Vicki strives to create a student-centered classroom. She says that she does this by allowing the students to suggest further topics to study within a particular unit and constantly encouraging them to express their feelings and thoughts on topics. She wants her students to feel valued and to have a strong sense of personal worth. She feels this is the best way to foster their independence and life-long learning.

Vicki says her classroom is "more science oriented" than anything else. Vicki teaches science in a very student-centered way. She explains that she always asks her students to express their own ideas and questions before beginning any science activity. She wants them to explore ideas and then come up with a hypothesis. She gives an example of an upcoming experiment where they will be working with ice and salt.

> So with the thermometers, I'm going to just post questions for them to think about and I'm going to put out the materials and the question would be, "What do you think would happen to the temperature if you put salt on the ice?" I'm going to set-up three cups where they have water, ice and salt. And then ask, "What do you observe happening?" And let them come up with it. That's different than "This is your materials and procedures." I might get what they discover and then go into that other mode. But I'm going to let them first just explore it.

She says that she was, and still is, very much influenced by her family in her interest in science and in education in general. Her father is a geologist, and she said that growing up, she spent summer vacations on geological trips with her family. They would often pull the car over so that he could show them the different rocks or why the trees grew different on one side of a fault line. Even now, Vicki takes trips like this with her father. But it is not just her father's influence. She has a large extended family and spent a lot of time during our interviews describing their many interests. She describes her mother as a "frustrated physician" who reads a Merck Manual for pleasure. Her aunt recently built her own telescope, and her uncle regularly goes on archeological digs. Her brothers, like her, are also very into geology, and another uncle is an airline pilot who is searching for Amelia Earhart's plane in the Pacific. Vicki emphasizes how much almost everyone in her family enjoys reading and always learning new things. She truly embodies the notion of "teacher as learner" and this is, of course, influences how her students view learning. She is by nature, an enthusiastic, high-energy person who is always ready to experience new things.

School Science Leader

Vicki is considered the science leader at her school. She says this is mainly because none of the other teachers want to take a lead in science activities. In fact, she mentions several times how she was tired of always having to be in charge of things just so that they will happen. She says she has tried to encourage the other teachers to take more initiative, but they haven't come through and this has been very frustrating for her.

One of the projects that Vicki has participated in is Science Fun Day at the Museum of Science and History. She partnered with the Children's Museum for two years where one year they did a project on electricity and the other year they did one on matter. She says her students really enjoyed it and they plan to continue participating. The Children's Museum was a good partner, she said, because they were active participants and supplied the equipment for them.

Vicki also had students compete in Invent Jonestown for four years where she served as a coach. This was a contest sponsored by a local business where students entered inventions and competed in several categories including creativity, design, usefulness and marketability. The students from her school won several awards and she spent many hours after school helping them to prepare. She says that unfortunately the business that was sponsoring it went out of business, but the district is continuing something like it and she plans to participate again.

Vicki has also run the science fairs at her school for the last five years and while at Pease, she sponsored an informal after school science club she would help the students in preparing their science projects. She also coached a group of third graders who won first and second place awards at their first Math Pentathlon competition.

In addition to these projects, Vicki is also the Science Committee Chairperson and Technology Committee Chairperson at her school and has been the third grade team leader for the last six years.

While Vicki has many things to be proud of in terms of her school leadership, she explains what she is most proud of:

> I'm the most proud of the fact that after 17 years in education, I still walk into my classroom with the love of teaching still inside me. I possess a sense of pride in the fact that I have made my classroom a place of active learning. I offer my students many hands-on opportunities that allow them to discover and explore many concepts. My proudest moments are when students ask permission to stay after school to read with me or work on a project. It is at these times that I know I have made a difference in the lives of the children I teach.

Using Informal Science

Field Trip Structure

Vicki says that each grade level is budgeted for two field trips a year. Although, she usually manages to take her students on three field trips when she has had a lot of parent support. They usually take one social studies oriented trip and one science oriented trip, and then they might go somewhere like the Children's Museum or a bigger trip such as Ivans Caverns as their third trip. Vicki says that whether or not they can afford to go on a third trip depends on the parents and if they have they have the funds to donate. She says that while at Fisher, they were able to do more of this because the parents were more involved than at Cooper.

Informal science experience gave her a <u>strategy</u> for teaching science.

Vicki stands out distinctly from the other teachers in the study in how she and her students have benefited from working with museums. She does not actively seek out informal science resources like the other teachers to ensure that her students experience the benefits of informal science. She usually goes on the allotted number of field trips a year and finds a way to work them into her curriculum. But in many ways, her experience with informal science has made a much more dramatic impact on the quality of science teaching her students experience.

While Vicki says that her classroom is "more science oriented" now, she says that when she first started teaching, that was not the case. Although she had an interest in science, she says she did not know how to teach it. She says, "I had the knowledge I just didn't have the 'How'." When asked if she had ever had any science methods courses in college, she says that she had one science methods course. The professor emphasized "discovery, discovery, discovery" which she says was fine but she felt that there was a missing element. Vicki explains that they were doing an experiment with different powders and trying to figure out what they were using different indicator fluids. But they had no idea what they doing and why they were doing it, even after they finished. It wasn't until later that she realized they were working with acids and bases. She expands on this:

> He just left it as, "Oh – it's an open-ended experience." So I took science methods but it was all into "Isn't this neat? Isn't this fun?" And I didn't see the science behind it. Another one I set up and I'm surprised no one even mentioned this to me when I was being observed, "Why don't we set up a pendulum and see how the pendulum swings and which one would swings so many times and use different weights." But I really didn't do the science – what is it about it? And since that aspect was missing and no one turned me around and said, "Have you thought about why you're doing it?" And so a lot of the science I did in college. ended up being, "Well, let's explore and let's play with it."

In 1987, Vicki began working with the Children's Museum – which was then called Discovery Center and was housed in a different facility. She worked there in the summers teaching science camp. She says the reason she took the job was because she was tired of life-guarding and thought it sounded like fun. She began by teaching just two weeks and then moved into working the whole summer. Vicki says they had programs set up at area schools and churches and they would run "How and Why" camps where they would take the kids on field trips and do hands-on science at the sites. When asked how she uses informal science, Vicki says, "I use it when I teach." She explains that the reason her classroom is so science oriented is because of her "experiences at the museum."

> When I started working with the museum, they would pack these boxes and label the science it was and what week it would be for. And for that week, everything would be ready in baggies. So I learned really fast how to put things in baggies and have my kit ready. So I was really teaching science just with a box and with whatever was around. And I thought, "I can do this in my classroom!" If you look through here (pointing to cabinets where boxes are stored) you'll see all of my supplies in boxes. I can pull it out as I go.

She says, "It gave me the 'How'. In fact, Vicki still uses the curriculum that she helped write for the summer camps as her science curriculum. She brought this out and showed it to me and said that I could borrow it but that she needed it right back because she uses it all of the time. Vicki explains that she learned how to do real investigative science where the students explore their own ideas and follow an inquiry approach. She also stresses the questions "What happened here?" and "Why did that happen?" and "What did not happen?" after all investigations. She knows the value in these discussions and does not want them to feel as she did in her college science methods course. She has also learned that she can teach science anywhere – she does not need a lab. As she says, "Give me a bucket, give me baggies. I can work it from there."

In addition to providing her with a way to teach science in her classroom, Vicki's experience working the summer camps exposed her to a wide variety of informal science sites in the area. These have included environmental centers, the recycling center, the landfill, Ivans Caverns, the zoo, William's Farm, Reynold's Farm and different departments at the university. She has returned to many of these sites for her school field trips since then, including an evening trip to the university's astronomy department to see their telescopes.

Although Vicki has decided to do other work in the summers recently (and use it more for vacations), she has taken her students to the Children's Museum on field trips and still called on them as a partner for Science Fun Day and to borrow "Stuffy" the anatomically correct doll for her school. Her experience in working at an informal science helped her to bring this interest into her classroom in a meaningful way. Not only have her students benefited, but the entire school as well, in that they gained an enthusiastic campus leader in science education.

JOE: INFORMAL SCIENCE SERVES AS A PARTNER IN PROVIDING STUDENTS WITH CHALLENGING OPPORTUNITIES IN SCIENCE.

The following is Joe's description of a current favorite project:

> One of the things that I'm working on is a Rocks from Space kit with an astronomer from the university. We put together a video on inquiry science. It's an inquiry about a mystery rock that kids get. The idea behind it is to bring meteorites into the classroom. Well, how do you bring meteorites into the classroom and make it a productive experience? Well, you either put it in a bag and let teachers check it out, which they probably won't do, because all they are is just big rocks. (He shows me the kit and meteorite.) So bringing them into the classroom, what do you do? This is a meteorite from the Odessa Meteor Crater. A lot of people don't know that there is even a meteor crater in Odessa. Well, this is a piece of the meteorite. "Where did this come from?" Well, you find out that it came from Odessa. "Why? What's in Odessa." "Let's look in Odessa." That's the progression. "Well, it could be a meteorite. How do we find out it's a meteorite?" "Let's take it to a resource, a scientist." So we went to the geology department and sliced off a piece and put it in an electron microscope. Well, one of the things that makes it a meteorite is the presence of nickel. Now what is interesting about this meteor crater is that during the WPA period, the work projects, one of the work projects that the government paid for was to find the meteorite. So this was a 200-and-some-foot shaft that they put down into the center of this meteor crater to see if they could find a meteorite. Of course, they never found the meteorite. As it turns out, the meteorite disintegrated on impact into small pieces. The guy that was head of this WPA Project lives here in north Jonestown. So we interviewed him. After the mystery was solved and we found out that we had a rock with nickel in it, a nickel/iron meteorite, we took a road trip to Odessa and met up with a guy there that did some meteorite collecting. He has his garage full of meteorites. All these things that come together with this rock in the classroom, and we're going to make that available to teachers. It's a cool idea. It's a lot of trouble.

Joe's enthusiasm about this project is infectious. He enjoys learning about all science, but astronomy is one of his most passionate interests. As he told me about this kit, I realized that his students must also be affected by their teacher's curiosity and probably understand what it's like to be a life-long learner.

Background and Teaching Experience

Joe is a fifth grade teacher at Meade Elementary in Jonestown I.S.D. where he has been for 3 years. Prior to this, he taught at Leyner Elementary for 19 years where he taught fourth grade, fifth grade and a third- fourth grade combination. Joe was the both the technology and science contact person at Leyner. He said that he made the move to Meade because he was ready for a change and wanted to move away from dealing with everyone else's technology. He wanted to focus more on his science interests.

Joe is known as a leader in science education, not only at his own school as Science Committee Chairperson, but also at the district level as a Science Curriculum Specialist, as well as a member of the District Technology Leadership Team. In addition, he is a leader at the state level, having served as Vice President of the Texas Marine Education Association and the Science Teachers Association of Texas, Co-President of the Texas Council of Elementary Science and recently as President of the Science Teachers Association of Texas (he is also the web master of this organization). He has also been involved in curriculum related activities such as serving on the writing team for the statewide science standards and has led many curriculum workshop trainings in both science and technology. He has been involved in bringing attention to informal science on a statewide level when he served on the Informal Science Education Action Team. In addition to his service, Joe has been recognized with many awards for his science teaching – most notably the Presidential Award for Excellence in Science Teaching in

1995. Interestingly, Joe is married to Kathryn (a kindergarten teacher also in this study) who has also won this prestigious award.

Joe has also been very active in using technology in his classroom. And due largely to the curriculum project he worked on with an astronomy professor from the local university, he was named an Apple Distinguished Educator. At one time, he was leading many workshops on technology and served as the technology contact person at his school, but he has cut back on these activities. He says that he was dealing more with questions like, "Tell me again how to connect with my email" and he tired of that. He enjoys using technology as a tool in the classroom, which he continues to do. But he has chosen to not be, as he says, the "Pied Piper of Technology." He says that, "Technology is a vehicle. It's not a curriculum. And science is a curriculum, and that's what I enjoy."

Joe stands out from many of the other teachers in this study due to the extent of his involvement in science education outside of the classroom. His true passion is science, and it is apparent that he delights in bringing this to his students. And this is where he says he excels and finds great satisfaction – in sharing this passion with his students.

Teacher as Opportunist

Joe did not know that he wanted to be teacher until after college. Although he says he had always had an interest in science, and almost went into oceanography, he decided to major in art – in which he had another strong interest. His degree was in studio art with a minor in radio, television and film. After working for a short while in a local news station, he then took a job as advertising director for a movie theatre chain. He says that he decided to go into teaching because he felt it would be a more rewarding profession. “I didn’t enjoy what I was doing in advertising and I didn’t think there was anything in it that I really wanted. I wanted something with a little more heart in it.” At that time, Joe knew that he really needed to have a sense of satisfaction in his work and so he made the move to teaching. He still looks at his profession that way. He strives to make it fun and rewarding for both himself and his students. He does this by involving his class in interesting science and technology projects and by creating a constructivist learning environment in his classroom. He explains how he teaches science this way.

> That’s how I teach is through science. It is certainly the thing that keeps me interested and involved. I enjoy what I do inside the classroom and out with science. It’s certainly an underserved subject in elementary school. The kids just hunger for it. Not to say that in fifth grade we do experiments on any kind of in-depth study, but presenting science in a constructivist way, where they get involved and question at their own level and find their own answers, and what you end up being is a guide for them to find their answer. That’s basically how I do the extracurricular project. It is guided by the things that the kids want to do.

Joe’s “extracurricular projects” include things like working with local informal science sites or community groups on a specific topic, experimenting with video editing after school, participating in electronic field trips and exploring their on-site pond. He says that in order to do these things, he has learned to approach teaching with an open and “flexible” mind. If he and his students are curious about something and an opportunity arises, then they are likely to pursue it. He explains this approach.

> Taking advantage of opportunity – I do that in the classroom. It's like the "teachable moment". But, it's how you react to situations like that is important to how much you get out of it. When something happens, you either pursue it, or you take another course and I enjoy pursuing opportunities like that. It's kind of a challenge. Things just happen. Sometimes you even put yourself in a position of not really knowing what's going to happen, but whatever happens, happens. And I think I mentioned that a lot of teachers don't feel comfortable with that sort of thing. It's like committing a crime. You don't commit the crime unless you're willing to do the time. You take it as it comes. And sometimes it doesn't work out as good as others. But it works. It's worked for me anyway. It keeps life interesting. It keeps the class interesting.

Joe repeatedly expresses his frustration at having to "drag others along" many times on interesting projects or field trips.

> Like the Science Fun Day, they are interested in it, but nobody wants to go up on a Saturday or stay after school for weeks on end to get ready for something like that. But I think it's an important part of education.

He says that while working as a grade level team is beneficial on most levels, when it comes to extracurricular projects, most teachers choose not to spend the extra time on it. While he understands the many demands and constraints on teachers, this is frustrating for him because it is limiting. He enjoys pursuing new avenues and embraces these opportunities. This is not often the case with many teachers. As he says, "Basically, I go with the flow as best I can. Serendipitous events are joyous to me. For some individuals, those sorts of events are stress-inducing".

Using Informal Science

Field Trip Structure

Each grade level is budgeted for one field trip a year and the fifth grade goes to Cirel Symphony Hall. The fifth grade has also asked parents at the beginning of the year to pay for a trip to Sea World and an overnight trip to Camp Adams - where they stay in cabins and participate in an environmental informal science program integrating many different subject areas. Joe says that because of the two big extra trips, they are hesitant to ask parents for additional funds for more trips. Last year, they were able to take an additional trip to a water treatment plant, which was sponsored by the City of Jonestown for all of the fifth graders in the district.

Informal science serves as a <u>partner</u> in providing students with challenging opportunities in science.

Due to Joe's curious nature, he delights in finding new and different ideas for bringing science to his students. He realizes that by reaching out into the community, he has access to the expertise and unique experiences that are out there – beyond his own classroom. As he states several times during out interviews, "I don't want to be in this alone."

Joe tends not to depend on the programs offered by informal science sites, except maybe for the fifth grade overnight trip to Camp Adams. He would prefer to work on more specific projects with people who are genuinely interested in doing so. He says that he enjoys being "challenged and focused" and finds satisfaction is working with others that do too. For this reason, he has found it difficult to work with many of the other fifth grade teachers because they don't necessarily want to put the extra effort in. Joe's emphasis on partnering with those in the community who share similar interests and expertise is reflected in the projects he talked about.

One of the projects that Joe has involved his class in has included Science Fun Day where they recently partnered with the Bats Society and held a "Bat Jeopardy". He says that they went out and saw a bat colony and studied bats so that they could share their expertise with visitors to Science Fun Day. They even were awarded the Dean's Award for their exhibit.

Another project began a few years ago with the Nature Center when they partnered with them to compete in the National Public Science Day Contest. Their pond study project and website earned them the Runner-Up Prize. During the course of the study, they went on multiple field trips to the Nature Center to study ponds. Yet, they did not stop there. They decided to continue their study of ponds and so they took on the pond on their own school grounds to "adopt". They partnered with the Watershed Protection Department. This has meant many after school hours for both Joe and those students that have taken a particular interest. He explains this.

> I've found that [using after school time] is the easiest way to get things done. For the Fond of Ponds project, we met over Christmas and went to the pond and fished and collected critters and floated around in the pond to see how deep it was. There were a lot of after hours kind of things -- afternoons and weekends. But if that's what it takes to make things interesting, shoot, I'm game. I have no problem with it.

They also participated in Science Fun Day that year and set up an exhibit on their Fond of Ponds project. Joe explains this.

> What we had at the Science Fun Day was we gave out little origami frogs. We had a frog that we got from the pond. I spent all my money trying to put together a little model of the drainage system, which didn't work and got water all over the place. So it just sort of sat there. We had a good time. We showed the pond quiz, and some people took the pond quiz on the computer.

Joe's emphasis on partnering with people in the community does not always mean that he and students travel to informal science sites – although it often has. Many times, it is simply bringing those resources into the classroom. Because Joe is so involved in science and technology outside of the classroom, he brings his knowledge and relevant resources to his students. He knows where to go for help. He also recognizes that more important than fact memorization is a true love of learning.

> There are a lot of things that still are magic in fifth grade. So concentrating and focusing on procedure and making it a true test of a hypothesis, those sorts of things are important, but learning about the different elements of the periodic table…there's just a lot about solid science that doesn't have a place in fifth grade generally. There are kids that are ready for that sort of thing. So in a way, my expectations have diminished a little over the years. But we've certainly had more fun, which is a real important ingredient for an 11-year-old. If you don't make it fun, you're not going to learn that much. You're not going to go away thinking that learning is fun. And learning *is* fun. It should be work, but you should have something to show for it at the end other than memorizing and that sort of thing.

He strives to instill this love of learning in his students through his constructivist teaching and learning approach. And this is where informal science comes in. Informal science has never been about memorizing a list of facts or formulas, but about stimulating the curious nature in everyone. As he says, "It's that constructivist situation that I enjoy the most and feel most stimulated by. In order to set that up, I use informal science."

SUMMARY

This chapter describes the very different ways in which these teachers use the resources of informal science. There is obviously no *best way* for an elementary teacher to use informal science. Ultimately, this depends upon the value that an individual teacher places on informal science. The values of the teachers in this study are reviewed below:

Kathryn: Informal science is an essential *resource* for teaching science and growing professionally.

Betty: Informal science is a *treasured gift* of science experiences she can provide her students.

Greg: Informal science sites are science *laboratories* for his class projects.

Suzanne: Informal science is the *bridge* to the world for her students.

Vicki: Informal science experience gave her a *method* for teaching science.

Joe: Informal science serves as a *partner* in providing his students with challenging learning opportunities in science.

The following chapter, Chapter Five, describes the findings in a cross-case analysis format.

Chapter Five: Findings: Cross Case Analysis

This chapter focuses on a cross case analysis among the teacher participants where, as the researcher, my interpretations predominate. In contrast, the voices and stories of the participants were the focus in Chapter Four. I have divided this analysis into different sections based on the major themes that emerged. Each section allows a look at how the teachers were similar and/or different from each other on these issues.

USING INFORMAL SCIENCE

How They Use Informal Science

After hearing the teachers' stories on their use of informal science, it is easy to see the striking differences in *how* they tend to use it. In order to visualize their similarities and differences, I have placed them on a continuum (see Figure 1) with an emphasis on *long-term partnership projects* on one end and an emphasis more on *science exposure through multiple field trips* on the other. *Long-term partnership projects* refers to projects where the teacher is involved with a particular site or organization on a long-term science project involving their students. An emphasis on *multiple field trips* means that a teacher takes students on many trips throughout a school year to different sites, but does not necessarily engage in a longer-term project or return for more visits within the year. And yet, it is important to realize that this is not a static continuum. The teachers' position will likely shift one way or the other depending on both internal and external factors.

Figure 1. Comparison Continuum of Informal Science Use

Greg   Joe   Kathryn   Betty   [Vicki]   Suzanne

Long-term Partnership Projects ⇒ ⇒ ⇒ ⇒ ⇒ ⇒ ⇒ ⇒ ⇒ *Multiple Field Trips*

Greg and Joe are on one end of this continuum due to the fact they both tend to focus on specific projects. Joe views informal science largely as a *partner* in providing challenging constructivist based science learning for his students. His focus is not so much on simply visiting informal science sites, but on working on specific projects. Similar to Joe, Greg views informal science sites as *laboratories* for his class science projects and enjoys the continuing partnership he has developed with the Nature Center. He focuses on one big science project for his class and utilizes that one informal science site. Greg's class is likely to visit the Nature Center seven or eight times and never travel to another informal science site in the area during the year.

Kathryn sees informal science as a *resource* for her teaching and professional goals. She calls on the expertise of the scientists and educators to help her do what she does best – teach. Kathryn takes her students on multiple field trips and takes an active role in planning for these. She also often calls on those in informal science for assistance in planning curriculum and as resources for content. I placed Kathryn closer to the middle of the continuum because she does not focus on exposing her students to as many places as she can, but rather on how the site's program fits into her curriculum.

Betty stresses how she greatly values the immeasurable power of informal science experience and works to bring that to her disadvantaged students. While she has worked on grant-funded projects in the past, she places importance on simply allowing her students to really see and do science through informal science experiences. And yet, she is not able to take her students' on as many field trips as she would like. Betty has been involved in several long-term partnership projects with informal science sites in the past and she was therefore placed closer to the middle of the continuum.

Suzanne takes her class on multiple field trips during the year and is therefore placed on the "multiple field trips" end of the continuum. Suzanne is somewhat similar to Betty in that she recognizes that exposure to the vast array of science resources in the community is greatly beneficial to students' learning. But she takes it a step further and says that it is her goal as a teacher to give her students a sense of awareness of their community. She is therefore determined to continue her many field trips because it is so important to her.

The teacher that stands out as the most unique in terms of how she has used informal science is Vicki. For this reason, she does not have a clear place on this continuum. She goes on the allotted number of field trips a year determined by her principal and does not appear to do a lot of pre-visit preparation or post-trip follow-up. And yet she is still considered the science leader at her school. She says that she has benefited from her informal science experiences in a much different way. Her work at the Children's Museum gave her a *strategy* for teaching science. She says she lacked the skills to teach science, although she had the knowledge and interest. I was at first reluctant to place Vicki on this continuum because she so clearly stood apart from the rest, but I have chosen to place her towards the *multiple field trips* end because while she does not go to as many places as Suzanne, she does go to at least three a year and has been involved in a partnership project with the Children's Museum in the past.

It is clear that the placement of the teachers on this continuum is related to the *value* or *role* that these teachers associate with informal science. Those teachers towards the "partnership" end of the continuum – Greg and Joe – explain that they are more interested in collaborative projects and working with interested people. They would therefore not seek out pre-designed programs or specific exhibits as much as they would an opportunity for their class to design an exhibit, for example, or research a topic they have chosen at the site. Those teachers at then "multiple visits" end of the continuum – Suzanne and possibly Betty – say that they value the experiences their students gain simply by visiting the sites and sometimes using their programs. Related to this is the fact that Greg and Joe (and even Kathryn) seem to be more selective in terms of their use of informal science sites, while Betty, and especially Suzanne, tend not to be. For example, Greg explains that he chooses not to re-visit the Children's Museum because he felt the it lacked "depth", while Suzanne was investigating additional places for her class to visit on a walking trip. From my interpretations, it appears that all of these teachers use informal science in ways that benefit their students, but also ways that benefit themselves, in terms of their own professional goals and desires. Where they are on this continuum reflects this.

Participation Level

While this continuum gives a cursory idea of how these teachers' use of informal science varies, there is also considerable variation in terms of their level of *participation* in the project or field trip experience. *Active participation* refers to things such as: talking with the museum educators before the trip to be sure that the program will fit their needs; adding onto the pre-planned program with activities at the site; spending time preparing for the trip so that the students gain more from it; and reflecting on the trip afterwards and relating it to what they had been studying. Active participation could also mean something like seeking out a partner for Science Fun Day.

While all of the teachers have been active participants in their use of informal science in one way or another, there are a few that stand out as the most assertive. Kathryn clearly stands apart from the rest because she sees many of these informal educators as colleagues and works with them to make the program suit her students. And from observing her, it was also clear that Kathryn stays in charge as the teacher at all times during the field trip. She will interject once in a while to help the students make a connection and stays in tune with what the informal educator is trying to accomplish in leading the students through an activity. And perhaps most importantly, Kathryn appeared to be sincerely interested and engaged in all that was going on. This was very apparent when I observed her class because the other teacher that she team-taught with was also there with her students. The contrast was amazing. As soon as Kathryn arrived, she took out magnifying glasses for all of her students that she had acquired at a recent science convention and encouraged them all to start exploring the area where they were eating lunch. They were finding lots of caterpillars and different insects and showing them to her. She looked delighted with each one. The other teacher simply stood back and talked with parents or reprimanded her students for something. And as they walked around looking at exhibits and animals after the program tour, Kathryn's class was attentive and asking lots of questions as she went through each one and explained it to them. The other teacher was not leading her class at all. Her students were hardly paying attention to their environment. With the exception of one or two parents with Kathryn's class, all of them also got into the "spirit" on the nature walk and were just as excited as Kathryn and her students.

The other teacher who stands out in terms of his active participation is Greg. While Greg does not take his students to multiple sites throughout the year, like Kathryn, he and his students have a clear goal in mind with their pond project and he expects to work side-by-side with the educator at the Nature Center to accomplish their objectives. Like Kathryn, Greg is very much at all times the "teacher" and the one in charge. While he looks to the Nature Center staff for expertise and some guidance, he is still actively engaged in what is happening. When I observed Greg at the Nature Center, like Kathryn, he appeared very enthusiastic about what they were doing on the trip.

Suzanne, like Greg and Kathryn, is also very much in control on a field trip. On the field trip I observed, she had prepared her students well and they knew what to expect. When I observed her at the Wildflower Center with her students, she led them on a nature walk and pointed out many interesting things along the way and related it back to what they had been studying. And the students appeared well-prepared because they pointed out flowers and plants that they recognized. Because she is so focused on her objectives on her trips, she can feel limited by the rules of the informal site. She describes her frustrations at the limitations she sometimes encounters in visiting sites.

> Generally, the tour is in for too short a time. And every time, I say, "Oh, okay, okay." Then I just stay as long as I want. I'm sure I'm breaking the fire code. That's my one complaint about these places around town is everything is too quick. They just think little guys don't have attention spans. So they make everything too short. That requires the teacher to then go back and fill in the blanks, and I'm not sure all teachers do that or are interested in doing that. (Suzanne, Interview 3)

While Suzanne may not seek out the expertise of the educators as much as Kathryn or focus on working as partners as Greg does, she did spend a lot of time telling me about how important it is to plan for trips and then relate it back to what they've studied once they got back. In addition, on many levels, Suzanne's participation surpasses the others' in that she goes on *so many* field trips a year – at least eight different sites. She is very aggressive in making sure her students are exposed to the science community.

Similar to Greg, Joe conveyed an interest in actively working with a partner on specific informal science projects such as the Science Fun Day with Galaxy Magazine and the university astronomy department. He sought these resources out because he has a genuine interest in the topics and he believes his students enjoy it too. I observed Joe on a field trip that was *not* one of these projects that he planned. The project was a city sponsored third grade trip to a water treatment plant. In contrast to how he described his involvement in other trips and projects, he did not take as active a role in this city sponsored trip. However, neither did any of the other teachers. The goal of this project was to get all of the third graders in the city to go to the water treatment plants and use the curriculum they had provided. The employees volunteered their time to lead the tours and it was more of an event than a program tour. The teachers did not set this up nor was there much room for them to customize it. In contrast, Joe talks about a trip they took to a city lake with the Watershed Protection Department.

> Now last year when we went to the city pond near downtown with the people that design and maintain it. That was pretty cool. First of all, we're going on a field trip. It's a cloudy, rainy, cold day. So I don't think anybody really feels like we're going to go anyplace and have any fun. [Laughs.] So we got away from the school clean, but even wet and icky and everything, we saw the pond in action with the rain flowing. We walked around the pond. It was pretty cool. They probably had no idea what they were going to get out of it. I'm not sure on many of the experiences that we had [that] they really knew what they were doing. It's up to the teacher to organize that sort of thing and I guess the students to look back on it, and be retrospective about it. Think about it in a way in terms of their learning. Of course, the kids don't do that. They just sort of stack it in the closet and refer back to it later. [Laughs.] I think the field trip experiences that I was able to provide last year were pretty rich for these guys. I think they really enjoyed it. (Joe, Interview 2)

Kathryn, Greg, Suzanne and Joe are fortunate in that they are still able to either take many field trips in a school year, or they find a way to involve themselves in multiple specific informal science projects. Looking at it this way, they are definitely more active in their level of participation and seeking out of informal science opportunities for their students. Betty and Vicki do not appear to actually do as much with informal science as the other teachers within a school year. Betty blames this on the increasing pressure to do well on the state standardized tests. They have to work much harder because her school has traditionally been low performing and serves a high number of disadvantaged students. As she says, "the school focus has changed." She also recognizes that she doesn't quite have the energy she used to in order to raise funds and plan as many trips. Betty became a grandmother and was diagnosed with breast cancer several years ago. She says these two life changes have shifted her focus somewhat and slowed her down. Betty manages to take her students to Port Conner every year, and is glad she has not given that up since that is her "passion."

Vicki, on the other hand, is able to go on more field trips each year due to a larger budget at her school and more parent support, but she doesn't seem to take as active a role as the other teachers. While she considers herself a "science person" and takes a sincere interest in informal science trips, I did not see that she planned heavily for the trip or talked with educators specifically about the trip before hand. When I asked her if I could observe her on a trip, she said that would be fine but they didn't have one planned yet. So she took some of my ideas on where to go and found one that had an availability. She has to justify how her trips fit into her curriculum, but there did not seem to be much preparation for it. Yet, while at the Museum of Science and History, she was definitely in charge and actively led her students through the exhibits. The other teachers attending the field trip weren't nearly as in control as she was.

Why They Use Informal Science

These teachers clearly use informal science in many different ways. It is also important to examine the reasons *why* these teachers choose to use informal science in whatever ways that they do. In looking across these teachers, it became clear that although they certainly use the resources of informal science differently, there was a consistent undercurrent of *why* they choose to use informal science at all. With the possible exception of Vicki, the one thing that they all share is that they believe that using informal science – whether visiting sites, calling on the expertise of scientists, taking advantage of outreach programs, or working on special projects – is essential to teaching science to their students. Science teaching is not complete without it. Some examples of how these teachers view the importance of informal science in their teaching of science follow:

> Who knows where they got the idea – pair scientists and science students with elementary students and middle school students, because it's a research fact that kids who have contact with a scientist, it's a high predictor for them going into the fields of science. You know, they don't know anybody in science. You know, it kind of makes sense, but there has actually been research done on it. (Greg, Interview 1)

> In the classroom, we can teach them science but they don't see a scientist at work. With these [informal science] programs, we can get hooked up with scientists actually at work and the kids can see what they actually do and that can really turn a child on. (Betty, Interview 2)

> These sorts of projects give you focus for bringing together resources and things that don't ordinarily happen in the classroom and give extraordinary experiences to a handful of kids that are either willing or happen to be a part of a project. (Joe, Interview 1)

> That's where it's all happening! I mean, what can you do in this little room? You can do a lot. But you can do a lot in here and a lot out there too. (Suzanne, Interview 1)

Kathryn also indicates how important it is to use the resources of informal science in her science teaching. As an example, her experience on a curriculum project with the university astronomy department and NASA on airborne astronomy research, has provided a vehicle for demonstrating to her students the value of looking at things in different ways. She explains the importance of this:

> We talked about looking at things in different ways and that when you're trying to explore something in science, you don't always look at it in the obvious way. You have to think about other ways you can do that. So it was very much an inquiry approach, because you're just thinking about, "Well, what's another way I could look at this? How would it give me different information?" So we did that. We explored light basically, because that's what they were dealing with was an electromagnetic spectrum. (Kathryn, Interview 3)

Vicki stands out as the only teacher in the study who does not stress the importance of regularly using informal science resources in her teaching of science. It was clear that while she has been involved in multiple science projects with her students, the real impact of informal science has been on how she approaches teaching science. It has given her a method of teaching science when she did not have one and this made a lasting impression.

While five of the six teachers have similar reasons for using informal science in their teaching, to gain a more precise understanding requires looking at the value they assign to the services and resources that informal science sites have provided them. For example, Kathryn uses informal science as an essential *resource* for teaching science and growing professionally. She described multiple ways that she has used informal science resources in her teaching – whether for content or an insight into teaching (such as the “ways of looking at things” from her astronomy curriculum project). This is therefore *why* she values informal science – for this service it provides her. Each teacher - even Vicki - values informal science for some service it provides (or has provided) them and their students. For this reason, the *why* and *how* of these teachers use of informal science is, in the end, difficult to separate. These are summarized once again below.

Kathryn: Informal science is an essential *resource* for teaching science and growing professionally.

Betty: Informal science is a *treasured gift* of science experiences she can provide her students.

Greg: Informal science sites are science *laboratories* for his class projects.

Suzanne: Informal science is the *bridge* to the world for her students.

Vicki: Informal science experience gave her a *method* for teaching science.

Joe: Informal science serves as a *partner* in providing his students with challenging learning opportunities in science.

Levels of Support for Using Informal Science

The teachers in this study have all used the resources of informal science sites regularly at some point in their teaching. How they are able to do so varies greatly among them. Their own passion for making these trips happen can take them very far, but the amount of support and/or resistance they receive from those around them has impacted them greatly. The support they receive from principals, districts, other teachers, parents and their own families has a tremendous impact on whether they are able to reach out into the community for the benefit of their students. This theme of *support* is common to all teachers and affects their use of informal science greatly. Yet they vary as to where this support, or lack of support, comes from. Some teachers have more difficult issues with their principals and districts while others struggle with lack of support from other teachers. I have separated these into different levels and described their effects on the teachers involved.

District

For those teachers in J.I.S.D. (the biggest district in this study), there is little or no mention of the impact of the district on what they do with informal science. The only exception was Greg. His Young Scientists Program has actually spread district wide to other schools and over the past few years, he has felt he has had to keep proving the worthiness of its existence.

> This was a big thing to get the Young Scientists Program here. We have to go to battle just about every other year because somebody will get a bright idea that this really isn't doing anything. At one meeting, I really kind of lost it. There was our area superintendent, my principal, and six or seven other principals here and then there was the science curriculum director for the district, and there was someone from the university. There was a whole bunch of people there and they were talking about why other schools like ours can't just get this program. Why does it always have to be, "No! We're not doing anymore! No! We did some, but we're not doing anymore!" (Greg, Interview 1)

The two teachers in smaller districts – Kathryn and Suzanne – have both benefited from being in wealthier districts and are allotted more field trips within a year than those in J.I.S.D.. Kathryn does not expand on the role of the district. Suzanne, on the other hand, has a strained relationship with the superintendent and spends a great deal of time talking about her issues with the district – especially with regard to the superintendent's attitude towards science. Suzanne says that this superintendent does not approve of Suzanne's animal-filled classroom and is personally offended by the snake Suzanne once had in an aquarium. Suzanne is afraid that her field trips might soon be taken away from her. Yet, she is confident in the support she receives from the other kindergarten teachers.

> The push now is to have everybody the same, and thank goodness Patty and Claire (the other two kindergarten team leaders for the district) are in place now because they believe in study trips. If there was anybody – in any of the team leader positions – in kindergarten who was under my new study trip program – or feeling pressure to go on them because everyone else was – we'd get in trouble. We can stand in a united front now because we all know that community based education is crucial to children's learning and outlook. It's going to change, I guess. There's just a general narrow-mindedness in our school district. Just narrow-minded. Not expansive thinking. I mean, they've never heard of Albert Einstein. There's no creativity. And it's supposed to be such an excellent district. (Suzanne, Interview 1)

It appears that being in a smaller district can have many benefits including more flexibility, but it can also be more easily swayed one way or another by the leadership at the time. This seems to be the case with Suzanne's district. She also spends some time talking about the benefits of working in the bigger J.I.S.D. in the 1970's and early 80's when she says there was renewed interest in science teaching and building connections with the community. She says she enjoyed the influence of the university on the district and she was teaching at schools that had benefited from many university interns and fresh ideas.

Principal

Three of the teachers have nothing but positive things to say about the support they receive from their principals in terms of their use of informal science. Suzanne describes her principal as “very wonderful” and “participatory” and said she loves science and math. Kathryn describes her principal as one that encourages leadership and self-initiative. She expects teachers to “make it happen” if they want something bad enough. Vicki also says that her principal supports her in her science emphasis and on any new ideas that she had. She says, “And my principal can get money. She’s good. Oh, yeah. Loans, grants, grant writing. She’s good. And I’ve yet to hear her say, ‘No, you can’t have that.’”

Joe and Greg do not specifically refer to their principals in terms of whether they support them in their use of informal science – or in any of their other projects. From Greg’s interviews, it appears that his principal is supportive of the Garza Young Scientists and encourages the relationship with the university. Greg appears to have a lot of freedom in what he does with his students and does not allude to being restricted in any way by his principal. Joe, like Greg, does not spend time talking about the role of his principal in his use of informal science. He appears to do well working on projects in which he has a lot of creative freedom and can work with others that value those kinds of constructivist, hands-on experiences. Neither Joe nor Greg seem dependent on the support from their principal, but nor do they indicate that they do not need it.

Betty is an interesting exception to the others' notions of principal support. She teaches at a very small, low SES school and she indicates that whoever is principal makes a big impact on the focus and direction of the school, including what she is able to do with her students in science. Her first principal (Julie) had been hugely supportive of her science interests and many projects and worked hard to write grants and work with the community to make exciting things happen at their school. After her retirement, the next principal (Laura) was not as interested in science and Betty says that she was young and did everything the district wanted her to and never questioned what was best for their school. Since then, they have had a new principal (Emma) who Betty says is more interested in science and a multidisciplinary approach to teaching. Below Betty reflects on the impact that changing principals had on her ability to do a lot of science with her students.

> I think changing principals three years ago made a big difference. Because when that principal came, my son was running the Science Center, because it got so big I couldn't do and keep up with everything. And he had support from Julie (past principal). But he never got support from Laura. He was getting paid. That was his job. Not very much, but as an aid. He loved it. So there for several years, we were just going great guns here, doing great things. [Then with Laura,] there was no support. Quite frankly, we were real aware of the fact that all she wanted to focus on was balanced literacy. She wanted to use the money that we were putting in over there on books. And that's what she did. So we don't have the Science Center anymore. It's been a huge change. I feel like we went from a small little jewel in the center of Jonestown. And people who knew about science knew that we were doing really neat stuff over here (Betty, Interview 3)

With Emma now having replaced Laura as principal, Betty says that she is hopeful that things will get better. Emma was very excited about Betty's marine science trip to Port Conner and told her that next year, she would find the money for the trip. In the past, Betty and her students have had to raise the money to be able to afford to go.

Other Teachers

These teachers are all considered the "science people" at their school, and, as such, they stand apart from other teachers in some ways. They are the teachers who are *always* doing their best to teach science everyday, even when it is not "required" by the district or principal. They enjoy teaching science and it is obvious from their descriptions of how they use science to interest their students in all of learning, and in their many outside science interests. *How* they and the other teachers have dealt with this science focus varies among them. All of them, with the exception of Greg, indicate that they have encountered resistance or a lack of interest from other teachers. Of these five teachers, Joe, Vicki and Suzanne all express frustration with the lack of support and the need to constantly accept sole responsibility for including their entire grade level in order to do what they wanted to in terms of informal science projects or trips. In contrast, Betty and Kathryn indicate a bit of indifference from other teachers, but they do not appear as affected by it.

Betty appears to accept the fact that she is one of the only teachers sincerely interested in science at her small school and she does not seem to expect much from others. There is only one other fifth grade teacher and she has little or no interest in teaching science. For this reason, there have been years when Betty has just taught science and math for fifth grade and this has been just fine with her. And since she is at such a small school, she rarely has to deal with coordinating trips for many classrooms.

Kathryn also did not indicate that the lack of support from other teachers limited her in any way or affected her use of informal science. In fact, she has mainly praise for her entire school and how they have worked together so well and supported each other on projects. The only frustrations she has were directed towards her partner-teacher. (They were teaching first and second graders) She says that they have different priorities and are not interested in the same things, but this alone does not limit her pursuit of interesting science projects and trips. So while she lacks support from this teacher, she seems to have found a way to "rise above" that problem and not let it affect her teaching. It should also be noted that because she is teaching multi-age students, she and her partner-teacher are their own entity and do not have to deal with several other classrooms.

Interestingly, Greg makes no mention of the support or lack of support he has received from other teachers. His program is self-contained and he does not seem to have to work with many of the other teachers in his school.

This is not the case with the other three teachers. When they go on field trips, they often have to adhere to the rule that "if one class goes, then everyone goes." This has been limiting for them. Joe expresses frustration with this and the fact that he would prefer to do things solely with his own class. He was able to partner with The Nature Center a few years ago on a funded project (Fond of Ponds) and he really enjoyed the freedom he and his students had to work as a class and not as a grade level. He also says that the other teachers seem to want the benefits of doing these projects, but they do not necessarily want to put the extra after-school and weekend time to work on them. He describes his frustration.

> So much nowadays a teacher's job is defined what they're willing to not do. [Science] is something that I choose to do, because it's fun for me and it's something that I want to spend a lot of time on. So it's a matter of professional priority for me to be involved as I am with science. There are teachers that I teach with that are interested in science, but it's kind of like, "Well, tell me what to do and I'll do it." So again, it's the pulling people along thing. If I had time to do it, I'd love to do it, but setting meetings and arranging…It's just that I don't want the fun in it to be diminished by having to deal with things by committee. I would love to work with somebody on Science Fun Day, but nobody really wants to do that sort of thing. When we do things in school as part of our curriculum, we share resources and things. That works out fine. But generally, when we talk about informal science, we're talking about above and beyond. (Joe, Interview 1)

Like Joe, Vicki expresses that she is tired of feeling like she must do the work for the whole grade level if they are to participate in any informal science activity. She describes her impatience with the other teachers when they expressed interest in taking a field trip to some caverns but never followed through.

> I told the person who wants to initiate this that she needs to [make the] phone call. That I'm not going to do it. And I keep looking at them, and I say, "You must phone call. Do it." So that's where I'm having the problem. They get busy doing something else, and then they go, "We forget," and then they get all perturbed about it. And I said, "Now y'all need to take care of it. If you want to go on a field trip to caves, you must call. How much is it? What about the buses? What about this?" So that's what I'm trying to do. And it's not working. (Vicki, Interview 3)

Suzanne, like Vicki, expresses frustration at having to plan trips for everyone in her grade level, but she feels that the teachers have at least a sincere desire to participate and seem to be appreciative of all that she does.

> If there isn't somebody like me saying, "Look – I'll plan them all. I'll write the permission notes, I'll put your name on them. All you have to do is collect the permission notes and get on the bus." If there's not somebody like me doing that, then study trips fall by the wayside. And in all fairness, there is so much pressure now to get from point A to point B with kids that teachers feel like they just can't afford the time. But it's also a matter of energy and work. And so I just do it. Originally, when I came Lake Travis, nobody was doing study trips. And I had come from Jonestown where we were really hopping around the city. So I just hired my own bus, had my kids pay their $5. And my class would merrily drive off into the sunset. Well, the other teachers started looking at my program and saying, "Well – we want to go too." Then it got kind of sticky because here I was going all of these places and if you were a parent, wouldn't you want your kid to be in that class so your kid could go to those places? They were feeling pressured. So I said. "Okay, instead of giving them up, let me take you into my fold. And we'll all go to all these places." Everybody went, "Yeah!" Kindergarten teachers are wonderful anyway. Kindergarten teachers are renowned for doing kinesthetic kinds of things. (Suzanne, Interview 2)

Where other teachers deal mainly with teachers at their own school, Suzanne also seems to work at the district level – where the other kindergarten team leaders are enthusiastic about their many field trips and want to continue them. Being a smaller district, she says that the kindergarten teachers can stand as a "united front" about the importance of field trips. The resistance comes mainly from other grade level teachers who feel like they cannot take their students to the same places that they have gone in kindergarten. They have complained that the students go to too many places in kindergarten and that they are therefore limited on where they can take field trips. Suzanne says that this is a ridiculous argument because students' levels of intellectual development change so much from year to year that they gain new insights from the same trips. Yet, she still worries that someone higher up in the district may agree with this argument and begin to limit her trips.

Another level of this theme of teacher support is that two of these teachers discuss feeling that they should restrain their enthusiasm for science and their own professional projects when in the presence of other teachers. Examples of this follow:

> It's hard to find a balance in getting people excited about a concept without sounding like you're tooting your own horn. (Suzanne, Interview 2)

> I can talk to you because we have the same interests. But lots of times if you talk to other people about these [science-related projects], it's like, "Oh, you're a showoff." (Kathryn, Interview 3)

Suzanne and Kathryn have learned how to stay involved in projects and go on field trips without making too much of a "fuss" about it. For example, Suzanne says that she used to quietly take her students on field trips by asking the parents for money and renting buses on her own. It was not that she did not necessarily want any of the other classes going with them - but that she did not want to risk not being able to go at all by asking the other teachers to participate. They eventually joined her on their own accord.

Parents

On the whole, a theme of "the higher the socioeconomic status of the families, the more pronounced the level of parent support for informal science activities" is common throughout this study. Parent support includes financial support, such as money for extra field trips, and other kinds of support, such as accompanying the class on day-trips and overnight trips or suggesting ideas for new field trips or projects. As Joe says, the amount of parent support "makes all the difference" in terms of their level of involvement in informal science projects. Kathryn, Joe and Suzanne teach at schools that serve families with a high socioeconomic status and they each comment on the tremendous support they receive from parents.

> The clientele here at Meade is better off than Leyner (school he previously taught at), and that means they can afford the money up front [for overnight field trips].. Now at Leyner, we would have a candy fund raiser every year and that would go toward paying for the expense. And we would only stay one night at Leyner. Here, we spend two nights. (Joe, Interview 1)

> Parents love these trips. They love these trips! So they go to first grade, and they say, "When are the trips?" (Suzanne, Interview 1)

> Oh, we have incredible parents. We have incredible kids. It's just like you couldn't work in a more ideal situation. And you know, lots of schools you don't think of your parents as your peers. I very much so feel that way here. I feel like they are my friends, as well as working with their children. (Kathryn, Interview 1)

Kathryn especially appreciates the relationships she has developed with parents. She comments on the rewards of involving parents on her overnight trip to Port Conner.

> It was a wonderful trip. We had lots of dads go this time. The excitement for me is – as much as watching the kids learn, is see the parents learn. They always go back and go "Boy – that's so cool! I didn't know that!" (Kathryn, Interview 4)

In contrast to the situations described above, Betty, Greg and Vicki teach at schools that serve families of a lower socioeconomic status and do not benefit from that same sort of parent support. These parents often do not have the extra money or resources to help support additional field trips or help chaperone overnight trips. Betty explains this. "Field trips are difficult for our school because to get parents to drive is very difficult. Parents are working very, very hard and they can't take off." (Betty, Interview 1)

Without parents suggesting interesting ideas for field trips or urging the school to organize more science-related projects, the students at these schools are simply not as likely to benefit from the resources of informal science sites. Yet, Greg is still able to somehow continue with his Young Scientist Program and Betty is able to take her yearly trip to Port Conner. In many ways, Greg and Betty have had to work even harder than the other teachers to accomplish what they have because they have had to without overwhelming support for what they are doing. For example, Betty expresses her frustration about trying to find transportation money for their trip.

> In fact, that's an issue right now with going to the coast. If the rental car company doesn't give us the neat rate they've given us in years past, are we really going to be able to go? What are we going to do about transportation? It's not like I've got parents that have got vans that can take us or that can provide money so that we can pay. (Betty, Interview 3)

Yet, neither Betty nor Greg is resentful of this and they even indicate that they understand the situations many of these parents are in. Betty explains why she believes parents have a difficult time becoming involved.

> I think parents – a lot of them – are scared of school. I think a lot of our parents maybe had a bad relationship when they were growing up. They're scared of school. A lot of them are drop outs themselves. When they can't read….It's very difficult. (Betty, Interview 2)

Greg shares this sentiment and understands that his students need additional academic support at school because they do not often get that at home. Betty and Greg both express that they realize that the parents of their students want their children to do well and do not fault them for not being as involved as other parents. And when these parents are able to accompany their children on a field trip, the positive affects on Betty are evident. For example, Betty relates a story of the rewards of having the opportunity to work with some parents on a recent overnight trip.

> I had so many parents go. I had almost like 16 parents with 23 kids. So you know how wonderful that was. We had so many parents that we ended up having to get another condo to house part of the parents in. And the parents then split the cost up. Some of them stayed with the kids [and] with me in the condos that I had for the boys and the girls. Then they got their own condo, too. The parents loved it. The kids loved it. And I've got all these parents who are now planning these trips to the coast. This always happens though. A lot of these parents have never been to the coast before. They had never seen the ocean, and they've never set their bare foot in the wet sand. It's phenomenal. I really think I enjoyed it so much more because I had so many parents. It's just the neatest. (Betty, Interview 4)
>
> She goes on to say,
>
> It's just watching the parents learn… seeing the enthusiasm on the parents' faces…. seeing how involved they get. And of course, when they children see the parents getting involved, what a huge lesson that is! Then seeing the interaction between the student and the parents is just great. (Betty, Interview 4)

Working with the parents in this way actually motivated Betty to continue her trips to the coast in the future. Prior to this trip, she had indicated that she might not be taking her students on these trips anymore due to her own exhaustion and a perceived lack of support from her principal. During our last interview, Betty seemed rejuvenated and felt she now had support from her principal, Emma. As mentioned earlier, Emma told her after this last trip that these would continue and she would help make sure that they did. In addition to the sense of enthusiasm from parents, this made all of the difference to Betty in terms of her level of excitement about her informal science trip to the coast. While the parents may not have been able to contribute as much financially or offer as much of their time as other parents at more affluent schools, when given the opportunity, they were eager to support their children's learning. The significance of parental support to these teachers is clear.

All of the teachers in the study appear to appreciate increased parent interest and support when it is offered with the exception of Vicki. She indicates that she had dealt with some very "controlling" parents at Fisher, the school she had previously taught at. While she says she and her students definitely benefited from the financial support, she says that it did not outweigh the negative effects of some of the more domineering parents. She explains the situation at Fisher.

> We had some low SES students and then those who would say, "Oh – I spent my summer in France!" So you had vast diversity in the group. And behaviorally – Pease parents were really involved but overall it was, "Do it my way or…" Controlling. And here [at Cooper Elementary] I don't find that. The parent involvement is a lot lower but when I do call they are there and they're supportive of me. At Fisher, you had to kind of earn that respect. Because if parents said they didn't like you, that was it. They could make you cry. One of my friends was crying after a PTA meeting because the parents decided to jerk her around. (Vicki, Interview 4)

Overall, it is apparent that parental support and the socioeconomic status of the families served by the school have a tremendous impact on the teachers' involvement with informal science. This is true for logistical reasons (finances and chaperones) as well as for motivational reasons. It is much easier for those teachers who teach at more affluent schools to take their students wherever they wish. The other teachers, like Greg and Betty, have to work much harder to gather the resources to make their projects with informal science happen. It is also clear that when these teachers feel they have parent support and are actually making a positive impact on parents and students alike, they are more motivated to pursue informal science opportunities.

Own Family and Resources

With the exception of Greg, all of the teachers in this study discuss their reliance on support from their own families and their own personal financial contributions in their use of informal science. Betty, especially, discusses the important role of her husband in her Port Conner trips. She says that he has always had a strong interest in marine science and has always accompanied her on these trips. Betty and her husband have also contributed financially to these trips. The rest of her family has also supported her trips. When asked how she manages to pay for her trips to the coast, she replies:

> I will tell you the first few trips that we took, my husband and I spent a lot of our own money. We did. To make it happen. And the first trip that we took, we stayed in a big beach house that belonged to my daughter's boyfriend. [Laughs.] And his parents, not just him, but his parents. (Betty, Interview 4)

As a single mother of two, Suzanne does not have the same sort of immediate family support that Betty has had, but she did have the strong influence of her scientist father growing up. She admits to personally paying for the upkeep of the many animals she keeps in her kindergarten classroom. And she does not have this money to spare, since she works part-time jobs every summer to earn extra money. Suzanne says that she spends approximately \$2,000 of her own money per year taking care of the animals. Yet, she doesn't seem to mind. As she says, "You do what you love."

Joe, Kathryn and Vicki also express that they had plenty of family support to do what they do as teachers. Kathryn and Joe, a married couple, share many of the same interests as elementary teachers with strong predilections for astronomy and marine science. They support each other's involvement in their many professional projects. Vicki also discusses the support she has received from her large, extended family in terms of her interest in teaching and science. Taken as a whole, these teachers are not alone in their interest in pursuing interesting science projects for their students. Family support is an important factor in these teachers' use of informal science. It is therefore easier for them to justify spending their own money on things such as food for an iguana (Suzanne), gas for a long field trip (Betty), or equipment for an elaborate water drainage model (Joe).

It is clear that the kinds of support that these teachers receive is critical to how they use informal science. Each of them is in a unique situation and consequently has different pressures and concerns. What they need in order to use informal science varies. Whatever their source of support, it is clear is that these teachers must feel *motivated* to use informal science, and the more support they benefit from – from whatever source – contributes greatly to their motivation to use the resources of informal science.

A FOCUS ON SCIENCE

It is not surprising that all of the teachers in this study are very science-focused in their teaching. As was highlighted in the individual case studies in Chapter Four, each of them claims to have a real affinity for science. As elementary teachers who are responsible for teaching all subjects (except for Betty, who teaches just math and science), they all say that they tend to teach from more of a science perspective. They also recognize that they stand apart from most other elementary teachers who tend to focus more on reading or social studies.

> I would say that most elementary teachers are not [science focused]– most elementary school teachers are very language arts focused. They're language arts people. So people like me who are really science people are not the common at all. I was the very weird bird at my school. But then that's why I got to do so many neat things for so many years because nobody else was into it. (Betty, Interview 2)

Because they have are known as the "science people" at their schools, these teachers are often presented with more opportunities to be involved in science-related projects. As Betty explains above, her reputation as a science advocate has allowed her to do many interesting things. Greg also claims that this was the reason he was given the opportunity to lead the Young Scientists program at his school. When someone from the university contacted his principal about this idea, the principal immediately called upon Greg because he was known for "doing science" at his school. This is also why many of these teachers have been asked to lead science fairs and other school science events. Not only do these teachers simply have an affinity for science, but they are all considered the science leaders at their school – and many times at the district and state level as well. While their leadership roles may vary greatly, it was very clear that, at least at the school level, they are the science leaders.

Joe has had the most leadership roles and takes his expertise beyond his classroom to the state level where he was president of the state science teachers association. In Texas, this is a huge organization where the annual conference has approximately 5000 participants. Curriculum writing is also a way for these teachers to use their creativity and expertise. Joe, Kathryn and Suzanne all discuss their involvement in curriculum writing and they emphasize the satisfaction they receive from being involved in these creative projects. It has been a way for them to take their professional expertise beyond the classroom.

While Kathryn and Suzanne have both found curriculum writing professionally satisfying, they differ in that Suzanne has focused on her own kindergarten curriculum she has recently published while Kathryn has been involved in multiple state and national curriculum projects where she has been the elementary science education specialist in the development of the curriculum and led many teacher workshops. In fact, Kathryn's dream is to take a national science curriculum and customize it for Texas so that it has more meaning for students.

Greg stood out from the others in that he is very focused on his specific project – the Garza Young Scientists. Yet, through his involvement in this now district-wide program, he has shown what "at-risk" students can accomplish in science. He and his students provide a model for other programs and they have shown that they can compete at a national level as they did in the AAAS National Public Science Day Contest.

Betty and Vicki appear to relate most of their involvement in science projects to their own particular classroom and school. They are both the science leaders at their school and have led activities such as the school science fair and after school science clubs. Yet, Betty has had the opportunity to be involved in some interesting larger projects such as the AAAS National Public Science Day Contest and the Mystery Project – an interactive nationwide integrated science curriculum project for lower-income schools.

It was also interesting that for most of these teachers, especially Suzanne, Kathryn and Joe, their involvement in leadership roles and curriculum projects outside of the classroom give them great professional satisfaction. They all talk enthusiastically about these projects and it appears to permeate into their everyday classroom teaching as well. As Kathryn said, “That’s the kind of professional level that I really like.” (Kathryn, Interview 3)

THEIR LOVE OF SCIENCE: INFLUENTIAL PEOPLE AND EVENTS

While all of the teachers in this study clearly have a love of science, there is a difference among them in terms of whether they reflect on the development of their interest in science. There is a clear division between the men and women of the study. The women all spend time reflecting on the significant events and influential people in their lives that turned them towards science. The men never discuss it. In fact, at a final interview with Joe, I asked him about this.

> JOE: ……..I enjoy teaching everything. But it just so happens that science is the area that I really enjoy and the kids really enjoy.
>
> CHRISTY: So what might you attribute that too?

> JOE: I don't know. I certainly have an interest in science. I guess I just have an interest in science. I've always enjoyed science. When I started to go to college – I was going to go into oceanography. But I kind of ran out gas and before I even started my coursework, I decided that I wanted to go into art. And up until then, the only art that I had taken was in high school where we made a beer mug (laughing). But I just wanted to be creative, so that's what I went to. But science is something that I've always been interested in.

In talking with Greg and Joe, it almost seems as though their interest in science is something they have never really thought about or thought was very significant. They talk more about their projects and science teaching, but not their background in science. The women, on the other hand, discuss specific events and people that have made a significant impact on their interest in science. Although I have already discussed what these women thought was relevant in terms of their interest in informal science in the case studies of Chapter Four, below I briefly review what they report as the influential people and events in their lives.

Kathryn's father was a geophysicist and she remembers him bringing home brain- teasers for her to try. She says that he always encouraged her to go into science and told her that she would love it. According to Kathryn, her mother was a naturalist, and introduced Kathryn to the world of biology. As she says, "Mom picked up every bug and every snake and every lizard and gave it to me." Kathryn also says that growing up near a beach endeared her to marine science and she now brings this love of the ocean to her kindergarten students.

Vicki spends a lot of time talking about her father's impact. He is a geologist. She says that while on family trips he would often stop the car and have them all get out to look at a certain rock formation or fault line. Even now, she accompanies her father on these geology trips. Vicki also discusses how her mother is really a “frustrated physician” because she has always had a strong interest in medicine. In addition to her family influences, Vicki also relates a story about an event in high school that peaked her interest in biology.

> I liked biology. And I had really excellent high school biology teachers and we really went into the whole system. We dissected and showed frogs. And we would have to take out the whole brain system from the brain stem forward. And then we pithed the frog. Oh yea. Well mine was still alive and I kept saying, “Mine is alive” and he was like, “No it’s not. I pithed him right and I looked at him and said, “His eyeballs are moving! He’s alive.”I had an excellent biology teacher. Then we went from frogs to a bird and each animal we did we had to take it out from the beginning of the system – like from the esophagus. We had a lot of anatomy. So with the frog the little lump on the roof of its mouth is how to differentiate if it’s a toad. And in order to get the grade we had to take it out from the very beginning of the system to the very end of the system. You couldn’t just like cut out part of the intestines. You had to do the whole thing. And then we would lay it out on the wax sheet and we would have to label each section and be able to discuss it. (Vicki, Interview 1)

Betty says that her major influence was her mother, who was a nurse. She vividly remembers her mother showing her how to look for cells in a microscope. This event, she says, “opened up a whole new world.” Betty also says that she enjoyed working in a medical research lab after college and that events such as this have really impacted how she teaches her students. She says, “All of that stuff comes back to help me be a good teacher to these kids. All the things that I’ve done”.

Suzanne’s real influence in turning her towards science was her father, who was a research mammalogist. She relates stories about going on turkey and deer counts with her father. Suzanne’s parents moved to Africa once she was grown so that he could study wildebeests. Visiting them on the Serengeti made a significant impact on Suzanne. She returned a few years later with her husband to live there and start a photographic safari company. Her true love is biology, which she emphasizes in her teaching. Suzanne even says that if she had to do it all over again, she would probably have been a research biologist – like her father.

Another interesting factor for these women is that they all had a parent who had a career in the sciences – and more importantly, *they* see that as a significant factor in their interest in science. Neither Greg nor Joe brought this issue up in our interviews.

SCIENCE TEACHING

The teachers in this study share a passion for science, and they also share a similar approach to teaching it. One thing is clear – they all strive to *do* science with their students. As Greg says, "Teaching science is nothing if you do it hands-on because all of them want to do it" (Greg, Interview 4). They know the value of a hands-on, investigative approach and they want their students to feel that they are truly doing science. Vicki explains her investigative approach with an example of an experiment she had recently planned for her students.

> I'm going to just post questions for them to think about and put out the materials and the question will be, "What do you think will happen to the temperature if you put salt on the ice?" I'm going to set-up three cups where they have water, ice and salt. And then ask, "What do you observe happening?" And let them come up with it. That's different than "this is your materials and procedures." I might get what they discover and then go into that other mode. But I'm going to let them first just explore it because then it has more meaning. (Vicki, Interview 1)

In listening to Vicki explain how she teaches science, I noticed that she values how her students are approaching the material. Much of what she says seems to indicate that she often uses a constructivist teaching/learning method.

Only two of the teachers, Kathryn and Joe, actually use the term *constructivist* and claim that they strive for it in their classrooms. And, interestingly, these are the two teachers that have been most involved in the development and implementation of some national curriculum projects. In addition, Joe has been the focus of, and co-author of a research study on his use technology in the classroom as a constructivist teaching tool.

> That's how I teach is through science. It is certainly the thing that keeps me interested and involved. I enjoy what I do inside the classroom and out with science. It's certainly an underserved subject in elementary school. The kids just hunger for it. Not to say that in fifth grade we do experiments on any kind of in-depth level, but presenting science in a constructivist way, where they get involved and question at their own level and find their own answers. And what you end up being is a guide for them to find their answer. That's basically how I do the extracurricular project. It is guided by the things that the kids want to do. (Joe, Interview 1)

Although Betty does not specifically refer to the word constructivism as it relates to teaching and learning, she does discuss the importance of providing relevant learning opportunities for students. She explains her reasons for using the resources of the Nature Center for information on aquifers in her students' study of landforms.

> I just felt if we're going to study landforms then we needed to talk about the landforms here because the kids will connect to it. I mean, quite frankly, they don't care about this mountain range in the northwest United States. They don't care. No matter what I try to do, I don't think it really exists to them. They haven't traveled very much – they don't know. So, it's not very important to them. Talk about the earth, the soil, the landforms in this part of the state, or right here close to us. We've got all sorts of things. As opposed to someplace else – someplace far away. Some of things we want to study are far away, but I just think that you can do both. It's important to have this as the basis. (Betty, Interview 2)

While all of the teachers clearly value hands-on, inquiry-based science, Betty is the only one who explains that she is not *doing* as much as she would like to. She says that she is not as free to do as much hands-on science as she once was. She explains that she had done much more inquiry based science projects a few years ago when she had a very supportive principal and there was not as much emphasis on passing the state's standardized tests. Because she teaches at a traditionally low-performing school, there is a lot of drill on basic reading and math. She explains this change:

> BETTY: What's happened is the focus of our school has changed tremendously.
>
> CHRISTY: How's that?
>
> BETTY: We were very focused on science and math for some time. But we're very focused on literacy and the standardized tests now. Come on…the big focus. For awhile, we used to write grants, I got involved in a lot of wonderful studies with several groups and we always went to the state science teachers conference and we don't do any of that anymore. The focus is totally literacy. Science takes a back seat to the whole school. A real back seat.
>
> CHRISTY: How do you feel about that?
>
> BETTY: Disappointed. Disappointed, but understanding that's where we are right now and there's not much I can do about it. You can still, in your own room, use science as your teaching literacy. But as far as the hands-on stuff we used to do – it's just not there. (Betty, Interview 1)

While Betty may not be doing as much as she would like, she also knows the benefits of working on longer-term collaborative science projects. In fact, all of the teachers, with the exception of Suzanne and Vicki, mention involving their students in these types of science projects. These teachers know that this collaboration reinforces for their students the fact they are doing real science. It is also important that these projects be of benefit to someone other than themselves. For example, Kathryn explains a project that her school is involved in where the students collect data for a worldwide project on weather patterns. The students therefore feel that what they are doing really matters. It is important to them that they are doing “real science” for “real scientists”.

This is also especially true for Joe and Greg who both know that the students will want to learn if they believe that their project is authentic and will make a difference. Joe’s pond project on the school grounds continued long after the official participation in the national Public Science Day Contest with the Nature Center. The students wanted to take care of their pond and sought out additional help from city’s Watershed Protection Department and Greg’s students are creating public education materials for the Nature Center’s use as part of their project. As Greg says, they feel good in that they were “giving something back” to the Nature Center.

“Science as a Hook”

With all of their enthusiasm for science, it is not surprising that all of the teachers talk about how they use it as way to get students interested in *all* of learning. Science is seen not only as a single discipline, but as a multidisciplinary tool as well. It seems easy for these teachers to get their students interested in reading or math when they can relate it to science. And they do this very often. As Greg says, “I just realized what an engaging tool that is even if it’s not your whole curriculum. If you can give kids something that they look forward to – to do. That’s what I use science as – really as a hook”. (Greg, Interview 4)

Joe also uses science as an engaging tool for learning. "I use it as a handle. In terms of what they're going to focus on – they're a lot of people in elementary education that focus on social studies or language arts or math. My main focus is science. (Joe, Interview 4)

Suzanne explains her focus on science.

> And to be truthful, when it's our phonics time, we just end up usually going off track completely and doing science. We do phonics and my kids leave being excellent readers, but we do a lot of science – a lot of thematic warming in. Science is great for that. The kids connect and they are so excited about words they can read like "metamorphosis" and "echinoderm." I was just teaching echinoderm to my low readers today. It fires them up that they can get information about what they really want to know about by reading. And it's a real powerful tool for them and they make that connection really quickly because the content is very heart felt. (Suzanne, Interview 2)

Fun was another word that these teachers use often in talking about science and all of learning. And they express that they are aware of how important it is to model this for students and create situations where learning can be fun.

> If you don't make it fun, you're not going to learn that much. You're not going to go away thinking that learning is fun. And learning *is* fun. It should be work, but you should have something to show for it at the end other than memorizing and that sort of thing. (Joe, Interview 1)

> That's what it is that is missing with our kids. We don't put science in the fun category in their heads if we're not doing hands on science with them from the time they're little. If you wait until they're older, they already have their preconceived ideas. (Betty, Interview 2)

Greg and Betty also talk about how science is an especially helpful tool in engaging their special education students.

> You see what an equalizer [science] is when you have special ed kids in the classroom. When you do hands-on stuff and it's not based so much on reading and writing, they can be so much more aggressive –they are more

willing to get into the lessons when you're talking about physical things. (Greg, Interview 4)

A lot of those [special ed] kids are just terrific in science. That would be the area they could shine – because they were good at hands on. A lot of them were really good artists and so when you made observations- we'd go somewhere and they would just study an iguana and they would sketch the iguana and they were fabulous. They would pick up on detail the other kids didn't. That got to be their neat area - with science. (Betty, Interview 1)

Confidence in Teaching Science

Not surprisingly, these teachers are very confident in their ability to teach science. This is apparent from the details of their many science activities and outside science interests, and from their own words. For example, Greg explains his approach to teaching other teachers how to use certain science kits.

If you know how to do it, you can grab one [kit] that's made for first graders on light and shadow and do all sorts of good stuff with it – quantify it and do all this for older kids, and introduce variables and things like that, but still use it for the younger kids. Or take something made for older kids and just take the numbers out of there. Just do some of the things as teacher demonstrations or whatever. But, that's the idea. To give them a little more – not only to train them in this kit, but just how you take a kit and make it work for you. (Greg, Interview 1)

Betty talks about her ability to adapt science activities for her students.

You see, I'm a biology major. So I just have a knack. I can take what we're studying and I can even take some stuff from the upper grades and bring it down to my kids pretty easily. And then tie in the reading and the writing. I was able to do that. (Betty, Interview 2)

Suzanne also discusses her proficiency with both the science content *and* her ability to teach it to her young students.

My baseline capabilities in terms of what scares me and what doesn't is way higher than a lot of peoples and it's real hard for me to drop back.

> Like I'm going, "What's so scary about helium?" And they'll say, "Well, I can't take that to kindergartners!" (Suzanne, Interview 2)

This confidence in teaching science also reflects on their use of informal science. They all enthusiastically explain how they have become involved in informal science and have sought out places to visit or opportunities for projects. Joe says that it involves some level of "risk-taking" because venturing outside of the classroom does not always result in success. He says that he enjoys this challenge but that many teachers do not. I believe this takes confidence to seek our, plan and organize these informal experiences.

Standardized Tests

The state's standardized tests are a major issue for several teachers. These tests are the main determiner of accountability for the state and much rests on the outcome for schools. Those teachers at the lower income schools – Greg and Betty – both spend much time discussing the problems they have with the pressure to pass the tests. The test preparation pushed by their principals and the district has been mostly about drilling the students on basic skills. And they know that their students are the ones that suffer from this kind of teaching. Greg says that most teachers at his school prefer to keep focusing on basic skills and drilling the test, but he says,

> The kids have skills but no content. They don't know anything. It's like a football team that knows how to do calisthenics and they're in good shape, but they can't play football. They don't think. We're not training our kids to think (Greg, Interview 1)

Betty also discusses the problems with focusing on passing the standardized tests. But she relates this more to the effects it has on science teaching at her school, and her opportunities to do hands-on science. She says that she does not have the freedom she used to. While she once took her "Westside Explorers" on short field trips after school in her big van, she says that she now spends her afternoons tutoring students on test skills. She relates this focus on the standardized tests to her motivations for maintaining some of her informal science connections.

> All that many kids get all day long is standardized test instruction. It's really sad. And these are kids that don't get science and social studies and all this stuff from the parents. So the only place they're going to get it then is school. And then if the focus of the school is on basic math and reading skills and writing skills and…unless you deliberately bring in science and deliberately bring in social studies, our kids are missing out on a lot. And I suppose that's one of the primary reasons I've become involved with things like the Nature Center. (Betty, Interview 1)

The other teachers in this study are not as preoccupied with the issues involved in passing the standardized tests as Greg and Betty. They teach at schools in middle to high income neighborhoods and say that they have students who have few problems passing the tests.

EXCEPTIONAL TEACHERS

Besides the major themes discussed above, there are some interesting similarities among the teachers that are worth noting.

- **Experienced Teachers:** All of the teachers have many years of teaching experience – at least 14 years. Kathryn, 29 years; Betty, 14 years; Greg, 14 years; Suzanne, 24 years; Vicki, 17 years; Joe, 22 years. Greg, Betty and Joe came into teaching later in life after having other careers.

- **Highly Educated Teachers:** Four of the six teachers have masters degrees beyond their undergraduate education. The other two have additional certifications. Kathryn has a M.Ed. in clinical remedial reading and a certificate in learning disabilities and in early childhood. She also has an additional 40 hours in science education. Betty is certified as a secondary science teacher and elementary teacher. She also has certification as a gifted and talented teacher. Greg has a M.Ed. in science education and is certified in elementary education. Suzanne has a M.Ed. in curriculum and instruction and is certified in early childhood. Vicki is certified in elementary education and ESL (English as a Second Language). Joe has a M.Ed. in curriculum and instruction and is certified in elementary education and art.
- **Teacher Leaders:** As I have described throughout the findings chapters, all of the teachers are leaders, at least at the school level. They all have additional responsibilities beyond what is expected of them in the classroom, and the majority of these leadership positions (official or not) are science-related.

SUMMARY

I have grouped the primary findings of this study below by theme.

Using Informal Science

How They Use Informal Science

- The teachers vary along a gradient of *long-term partnership projects* to *science exposure through multiple field trips*. The teachers, therefore, use the resources of informal science sites in many different ways.
- The teachers also vary somewhat on their level of *participation* in informal science trips/projects. In other words, some teachers seek out resources more actively than others. Yet, even the most "passive" teacher was clearly the leader for her grade level when they visited an informal science site and was actively involved in leading her students. On the whole, these teachers tend to pre-plan their trips, often with the help of informal science site staff and seek to customize it for their students.

Why They Use Informal Science

- Five of the six teachers express how important informal science is to their science teaching.
- The teachers value different things about informal science. These include:

  Kathryn: Informal science is an essential *resource* for teaching science and growing professionally.

  Betty: Informal science is a *treasured gift* of science experiences she can provide her students.

Greg: Informal science sites are science *laboratories* for his class projects.

Suzanne: Informal science is the *bridge* to the world for her students.

Vicki: Informal science experience gave her a *method* for teaching science.

Joe: Informal science serves as a *partner* in providing his students with challenging learning opportunities in science.

Levels of Support for Using Informal Science

- The teachers discuss support from the school district, principal, other teachers, parents, and their own families.
- The teachers all express how important support is to their use of informal science. Yet, where this support comes from varies greatly among them.
- Those teachers who teach at schools in higher income neighborhoods depend largely on parental support. Those teachers who teach at schools in lower income neighborhoods depend more heavily on the support from their principals and/or specially funded projects.

A Focus on Science

- All of the teachers claim to be very science-focused in their teaching.
- All of the teachers tend to be the science leaders at their school. Several of the teachers are also leaders beyond their school – being involved at the

district, state and even national level on curriculum projects and other science-related projects and committees.

Their Love of Science: Influential People and Events

There is a clear difference among the men and women on this issue.

- The women all reflect on the significant events and influential people in their lives that turned them towards science. The men never discuss it.
- The women all talk about at least one parent with a career in science who has strongly influenced them. The men never discuss their parents.

Science Teaching

- All of the teachers talk about the importance of a *hands-on, investigative approach* to teaching science.
- Four of the six teachers also discuss the importance of involving their students in longer-term *collaborative science projects*.

Science as a Hook

All of the teachers talk about using science as way to get students interested in all of learning. They also think that it should be fun and strive to model this for their students.

Confidence in Teaching Science

- All of the teachers express confidence in their ability to teach science.

Standardized Tests

- Two teachers, Greg and Betty, who teach at schools in lower income neighborhoods, both discuss the problems associated with a school focus on test preparation. They feel it takes away from "really educating" the students.

- The other teachers, at schools that traditionally do well on these tests, do not seem concerned with these same issues.

Exceptional Teachers

- All of the teachers are highly experienced in teaching– ranging from 14 years to 29 years.
- These teachers are highly educated. Four of the six have advanced degrees and the other two have additional certifications.
- They consider themselves leaders at their schools.

The following chapter, Chapter Six, is a discussion of the findings as it relates to the literature, as well as my own interpretations of the findings.

Chapter Six: Discussion and Interpretations

The focus of this study was how and why some teachers use the resources of informal science on a continual basis. Some of my preconceived ideas about these teachers were that they would have a strong affinity for science and would have developed some type of partnership with an informal science site (see Appendix A for my Researcher as Instrument Statement). I found that they all *do* have a strong affinity for science, but they have not all necessarily developed a relationship with an informal science site. These teachers value different things about informal science and they therefore tend to use it in very different ways. In this chapter, I expand on these issues and relate these findings to the relevant literature.

A FOCUS ON SCIENCE

The Good Science Teacher

The notion of a "good teacher" is largely subjective. It is therefore difficult to actually determine whether a teacher is a "good" teacher (Cruickshank, 2000). And while the purpose of this study was not to determine the effectiveness of their teaching, it was clear from these teachers' descriptions that they considered themselves to be good teachers – especially of science. For example, Betty expresses her confidence in her ability to teach science,

> You see, I'm a biology major. So I just have a knack. I can take what we're studying and I can even take some stuff from the upper grades and bring it down to my kids pretty easily. And then tie in the reading and the writing. I was able to do that.

In addition, in searching for teacher participants, I relied first upon referrals from museum educators, and secondly upon suggestions from other teachers. I was simply looking for teachers who used informal science on a regular basis, but I often heard, “He is an excellent teacher.” Or “She is involved in so many projects, it may be difficult to contact her.” In fact, I had several referrals for the same teachers. Their names were known throughout the elementary education community as excellent, innovative science teachers. Yet, I use the words, “good science teachers” loosely because of the fact that good science teaching can take many forms and is interpreted differently by many people. From my own interpretations, they would all likely agree that they are indeed good science teachers and would recognize science teaching as one of their greatest strengths as a teacher.

One indicator that these teachers are likely to be examples of good science teachers is the fact that two of them, Joe and Kathryn, have been awarded the prestigious Presidential Award for Excellence in Science Teaching. The teachers that receive this award are known to be exemplary teachers. These teachers must demonstrate:

- Subject matter competence and sustained professional growth in science and in the art of teaching;
- An understanding of how students learn science;
- The ability to engage students in direct hands-on inquiry;
- The ability to foster curiosity and to generate excitement among students, colleagues, and parents about the uses of science in everyday life;

- A conviction that all students can learn science, and a sensitivity to the needs of all students' cultural, linguistic, learning, and social uniqueness;
- An understanding of the relationships of science and mathematics to each other and the interconnectedness of all subject matter;
- An experimental and innovative attitude in their approach to teaching; and professional involvement and leadership. (Horizon Research, Inc., 2001b).

According to their comments, the teachers in this study model many of the standards for science teaching described in the National Research Council's (1996) *National Science Education Standards*. They all describe their teaching as being very hands-on, although Betty says that she does not do as much as she would like anymore due to a focus on passing the state standardized tests at her school. And they describe student-centered inquiry activities as being central to their science teaching. This is supported by the National Research Council (1999), which states that, "Inquiry into authentic questions generated from student experience is the central strategy for teaching science." (p. 31). And as the National Science Foundation (1999a) emphasizes "Inquiry teaching leads students to build their understanding of fundamental scientific ideas through direct experience with materials, through consulting books, other resources and experts…" (p. 7). The teachers with whom I spoke strongly reflect this image partly due to the fact that they rely on the resources of informal science. From my interpretations, they highly value a student's direct experience with materials. Using informal science resources is also considered an important part of effective science teaching. The National Research Council (1996) states, "The school science program must extend beyond the walls of the school to include the resources of the community."

The teacher as facilitator is another concept that is supported by the National Research Council (1996). Based on my observations and teachers' comments, all of these teachers appear to take a facilitative approach to their teaching of science. I observed Kathryn as a facilitator on a trip to the Nature Center where she subtly guided her students through an observation activity. They listened carefully to the sounds of the nature preserve and made their own visual observations that they reported back to the class. And Vicki describes encouraging her students to develop their own hypotheses and plans during science activities. Joe makes a point to emphasize his role as facilitator. He says, "[I] present science in a constructivist way where [the students] get involved and question at their own level and find their own answers. And what you end up being is a guide for them to find their answer." Greg also discusses the importance of the facilitation of inquiry skills,

> I believe it is human nature to problem solve and inquire into all phenomena of the universe. We, as teachers, do not need to teach problem-solving and inquiry as much as we have to revitalize and reestablish it in the student's life.

The teachers also tend to use collaborative work extensively in their science teaching. This is also supported by the National Research Council (1999) which states, "Effective teachers design many activities for group learning, not simply as an exercise but as collaboration essential to inquiry." (p. 50). Joe and Greg, especially, describe authentic group project work and make it a regular part of their science teaching.

While these techniques are all essential, I believe that one of the most important components of good science teachings is *enthusiasm*. From my interpretations, these teachers were very enthusiastic. They had such great enthusiasm not only for science, but for learning in general. The National Research Council (1996) states, “Teachers who are enthusiastic, interested, and who speak of the power and beauty of scientific understanding instill in their students some of those same attitudes.” (p. 37). The teachers in this study are curious, life-long learners. Vicki’s geology excursions with her father, Kathryn and Joe’s regular scuba-diving trips, and Suzanne’s native landscaping interest all testify to this. They regularly bring all of this into their teaching, and their students likely benefit. Mullins (1998) found that the more experienced teachers in her study discussed how the learning that occurs on well-planned field trips is an enduring, lifelong kind-of learning. Based on my interpretations, these teachers delight in this kind of learning, and so they naturally want their students to experience this as well. Mullins (1998) also observed that those students with more experienced teachers on field trips became more deeply involved and interested in the task at hand – such as searching for salamanders near a river bed. This was similar to the effect that Kathryn seemed to have on her students at the Nature Center. I observed the students asking questions and discussing what they saw as they walked through some of the animal exhibits. This was in contrast to another class in which the students looked just as disinterested as their teacher as they rushed passed the same exhibits.

Science Leaders

In addition to modeling many of the characteristics of what can be considered "good" or "quality" science teaching, the teachers in the study are all science *leaders*, at least at the school level. Participation in the planning of the school science program is described in the National Science Education Standards (National Research Council, 1996) as being an important part of the role of an effective science teacher. This theme of "science leader" was constantly recurring throughout analysis. While they vary greatly on their level of involvement, the teachers in this study are all responsible for the majority of science projects and activities that go on at their schools. For example, Betty and Vicki have led many after-school science clubs and activities and are both responsible for the science fairs at their schools. Suzanne has led her district in the planning and coordination of the many field trips for kindergarten. Greg teaches a special fifth and sixth grade class that centers around science. His class has served as a successful model of the Young Scientist Program. Kathryn has worked to bridge the gap between scientists and educators by serving on several state and national level science committees as the elementary educator. And Joe served as the president of the state science teachers association. These are just some of the ways that all of these teachers have been science advocates and science leaders. As described earlier, the teachers in this study are confident in their ability to teach science and Ramey-Gassert et al. (1996) found that teachers with confidence in teaching science, were "independent and *professionally active*" (p. 298). She further found that they tended to want to improve science teaching for students, other teachers, and for preservice teachers. And Qualter (1999) found that the teachers in her study of good science teachers were all professionally active as well.

Based on my own interpretations, the teachers in this study are often given more opportunities to take leadership of interesting science projects or activities simply because they are known to have an interest in science. They indicate that they are a minority at the elementary level and so they are called upon frequently to serve on committees or lead projects. While all of these teachers are actively involved in the science activities at their schools, a few, like Joe and Kathryn, have taken the next step and have sought out professional involvement on a state and national level.

Attitudes Towards Science and Science Teaching

> "I'm pretty excited about exciting people about science…I *love* teaching science. The kids *love* doing science." (Kathryn)

> "Kids just love stuff like that. They just love [science]. And it's what makes me feel good about teaching. If I couldn't do those things, I'd go crazy." (Suzanne)

> "That's how I teach is through science. It is certainly the thing that keeps me interested and involved. I enjoy what I do inside the classroom and out with science. It's certainly an underserved subject in elementary school. The kids just hunger for it." (Joe)

The teachers with whom I spoke all have a strong passion for science. This is clear from their excitement when they talk about science and science teaching and from the many projects they involve themselves in related to science. The National Science Education Standards states, "Teachers who are enthusiastic, interested, and who speak of the power and beauty of scientific understanding instill in their students some of those same attitudes." (National Research Council, 1996, p. 37) Furthermore, Ramey-Gassert, et al. (1996) found that teachers who had always had an interest in science as well as a desire to teach science were more effective science teachers. Time spent on science teaching and learning constituted a large part of those teachers' days. Similarly, the teachers in this study also report that their curriculum tends to be largely focused on science.

In addition to having a positive attitude towards science, it was also found that these teachers have *confidence* in their ability to teach science. For example, Suzanne describes her proficiency in teaching seemingly complex science concepts to her kindergarteners,

> My baseline capabilities in terms of what scares me and what doesn't is way higher than a lot of peoples and it's real hard for me to drop back. Like I'm going, "What's so scary about helium?" And they'll say, "Well, I can't take that to kindergartners!"

Based on my interpretations, having confidence in teaching science is also important to these teachers' use of informal science. They indicated that they had the confidence to reach out into the community and use the resources of informal science. Many teachers lack this confidence. This is supported by Mullins (1998) who found that teachers with more informal science experience considered *fear* within the teacher to be the most significant obstacle to teachers implementing field trips. Mullins (1998) also reported that teachers "must be willing to expose themselves to failures and to make mistakes, to have the courage to explore themselves, and to be open with their students" (p. 136). This is echoed in this study by the words of Joe on his choice to take on interesting informal science projects:

> Taking advantage of opportunity….It's kind of a challenge. Things just happen. Sometimes you even put yourself in a position of not really knowing what's going to happen, but whatever happens – happens. And a lot of teachers don't feel comfortable with that sort of thing. It's like committing a crime. You don't commit the crime unless you're willing to do the time. You take it as it comes. And sometimes it doesn't work out as good as others. But it works. It's worked for me anyway. It keeps life interesting. It keeps the class interesting.

Having a positive attitude towards science and confidence in science teaching is important to a teacher's ability to teach science well. Teacher efficacy, or confidence in teaching, has been found to be one of the most significant factors influencing teachers' work (Ashton an Webb, 1986; Smylie, 1990) and is an important factor in teacher motivation (Ashton and Webb, 1986).

The fact that the teachers in this study have a strong passion for science was clear and from my own expectations, not surprising. And yet, based on my search of the literature, there is nothing that deals with this connection between teachers' interest in science and their use of community resources. To take this further, it is valuable to study the *influences* on this interest in science. The majority of the teachers seemed to feel that it was important both to their science teaching and use of informal science.

Influences on Attitudes Towards Science

For most of the teachers in this study, the most significant influence on their attitude towards science was their parents. Four of the teachers report that at least one of their parents had a career in science. Kathryn's father was a geophysicist; Vicki's father was a geologist; Betty's mother was a nurse and lab technician; and Suzanne's father was a research biologist. The important factor is that *they* believe this to be a significant reason for the development of their interest in science. They reflect on time spent with their parents "on the job" doing such things as looking for turkeys, counting red blood cells under a microscope, and observing rock formations. Kathryn also says that her mother was an elementary teacher and a "naturalist" who would show her every lizard and bug. The powerful influences of parents on the development of positive attitudes towards science is supported by Ramey-Gassert et al.(1996) and Talsma (1999).

While the women in this study all spend much of their time reflecting on their love of science and the influences on this love of science, the two men do not. The men tend to focus on *how* they use informal science and how they teach science, rather than *why* they do so. Based on my interpretations, it was important that these women have strong parental influences in order for them to have developed an interest in science. Many researchers believe that science has traditionally been portrayed and practiced as inherently masculine (Rosser, 1989; Roychoudhury, Tippins, and Nichols, 1995). These women therefore distinctly remember experiences which shaped this interest when most girls were feeling alienated from science. Furthermore, Roychoudhury et al. (1995) suggest that women have a general inclination to make connections with what they are learning. They state further that "if girls do not have the opportunity to embed science in their life, they might remove themselves from the arena." (Roychoudhury, et al., 1995, p. 916). The women in this study were able to make strong connections between science and their own lives due to their positive science experiences growing up. Based on my interpretations, the men in this study, in contrast, seemed to accept their science interest as “matter of fact” as though they might have said, “Of course I’m interested in science. Why wouldn’t I be?”

While the parental influence remains the most significant for most of these teachers, a secondary influence was their experiences with nature. Kathryn, Betty and Joe all reflect on the role of their outdoor experiences. Joe discussed living in Virginia near the Potomac River and the “life science stimulus” that he experienced. Betty says that growing up on a farm cultivated her interest in science and Kathryn explains the significance of growing up near the coast as being a large reason for her continued interest in marine science.

> I always loved the beach, all my life. Growing up with my parents taking me on vacations to beaches all of the time – I’ve always had a natural interest and love for the beach. I lived along the Texas coast and the Louisiana coast most of my life. When I was in New Orleans, I lived on Grand Isle – which is in Louisiana. I lived in Sinton – which is only like a few miles from the Texas coast. So I lived close to the coast a lot. (Kathryn)

Similarly, Ramey-Gassert et al. (1996) found that the majority of teachers who had always enjoyed science grew up in rural settings or where exploring the natural areas was a common occurrence. In addition, Talsma (1996) found that 63 % of preservice teachers in her study referred to out-of-school experiences as significant influences on their attitudes towards science. They referred to their experiences at museums, on camping trips and in and around their own home.

Interestingly, Qualter (1999) in an article entitled, “How Did You Get to be a Good Primary Science Teacher?” described only experiences as adults – as preservice teachers or as practicing teachers – as having significant influences on interest in teaching science. Yet, this was likely due to the focus of the interviews and observations which centered around teachers' "personal professional history with particular emphasis on the development of their science teaching practices" (p. 78). The emphasis was therefore not on the development of general interest in science or attitudes towards science, but on teaching practices.

All of the teachers in this study report that they developed their interest in science early on. Even Greg, who only briefly reflects on his interest in science, says that he had an interest in physics in high school and had planned to major in physics in college. Yet, according to the literature (e.g. Qualter, 1999; Ramey-Gassert et al., 1996; Talsma, 1996), many elementary teachers become exceptional teachers of science due to positive experiences as undergraduates or through professional development experiences later on. This therefore provides good reason for an emphasis on continued improvement upon science methods courses for preservice teachers as Kelly (2000) points out, and on better quality professional development opportunities for teachers. Kathryn, who had already developed an interest in marine science, reflects on the impact of professional development experiences on her teaching.

> The actual interest in teaching marine science began when I went to the university's teacher workshops. Dick used to have funding through Sea Grant – where he did about four [workshops] a year. And one of them was an introduction to coastal systems - you go in the marsh – you go on the boat. I guess that was the first time that I just thought it was really neat. He always shared curriculum at that time, and it was always curriculum that was for middle school and high school. After I went, I drug a couple of friends from elementary school and we kept saying, "Where's the elementary stuff?" And finally Dick said, "Why don't you write some?"

> So my friend Julie and I started working on writing some stuff. We just started writing songs, and activities and Dick would help us with the science and with resources to read. And through our experiences, we knew what was important to pull out of the coastal systems. And all we had to figure out was ways to do it for the kids. (Kathryn)

The majority of the teachers in this study clearly indicate that they believe that their interest in science is a primary reason for their use of informal resources in their teaching. And those teachers who do not reflect on their interest in science (Joe and Greg) clearly exemplify teachers who have a strong passion for science. From my interpretations, an interest in science has therefore been important to their decisions to use informal science. Apart from, as Suzanne says, "doing what you love", there is another reason that most of these teachers provide as to why they use informal science – to benefit their students in their learning of science.

USING INFORMAL SCIENCE

Why These Teachers Use Informal Science

When asked why they use informal science, the majority of the teachers in this study indicated that it was an important part of their science teaching. With the exception of Vicki (who said that she *learned* how to teach science *from* her informal science experiences), all of the teachers consider their use of informal science essential to their teaching of science. The teachers describe this:

> These sorts of projects give you focus for bringing together resources and things that don't ordinarily happen in the classroom and give extraordinary experiences to a handful of kids that are either willing or happen to be a part of a project. (Joe)

> In the classroom, we can teach them science but they don't see a scientist at work. With these [informal science] programs, we can get hooked up

> scientists actually at work and the kids can see what they actually do and that can really turn a child on. (Betty)

With the many advantages that informal science learning offers – such as being open-ended and learner focused (Wellington, 1990) and encouraging hands-on, inquiry-based teaching and learning methods (Inverness Research Associates, 1990), it is no surprise that these science-oriented elementary teachers are drawn to using informal science. Two of the teachers specifically discuss their constructivist approach to teaching and learning and several others alluded to it. Their tendency to use more informal science in this kind of teaching is indirectly supported by Kelly (2000), who described the benefits of including informal science as a central component in a constructivist-based elementary science methods course.

The National Science Teachers' Association has recognized and encouraged the use of informal science sites by schools (NSTA Informal Science Advisory Board, 1998). The NSTA Position Statement on informal science education states that "A growing body of research documents the power of informal learning experiences to spark curiosity and engage interest in the sciences during school years and throughout a lifetime" (NSTA Informal Science Advisory Board, 1998, p. 30). The teachers in this study know this and indicate that they believe their students have benefited from their experiences with informal science. Joe discusses how informal science experiences have fit into his approach to teaching and learning:

> If you don't make [learning] fun, you're not going to learn that much. You're not going to go away thinking that learning is fun. And learning *is*

> fun. It should be work, but you should have something to show for it at the end other than memorizing and that sort of thing. (Joe)

Another interesting finding on why these teachers use informal science is that Betty and Greg, who both teach at low SES schools with many “at-risk” students, discuss the powerful influences that informal science has on these particular students. They mention two reasons for this. One is that it exposes these students to real scientists. Most of these students have never personally known a scientist. When they begin interacting with scientists, they can begin to see themselves in that role. The second reason mentioned for why hands-on, inquiry-based science and informal science particularly benefited “at risk” students was that it gives these students confidence. Betty discusses how her normally withdrawn students become enthralled with intricately drawing the animals in the science center. And Greg describes how one of his students came to love physics because he could use his expertise about bikes in learning about how gears and pulleys work. It can give some of them a different medium in which they can excel – outside of the normal confines of the classroom and textbook learning. Using informal science to reach “at-risk” students is supported by Ramey-Gassert (1997), who described the advantages of using relevant, realistic museum materials and settings to engage normally withdrawn students.

With the exception of Vicki, all of these teachers indicated that using informal science is simply a natural extension of their science teaching. They appear to incorporate their experiences and resource material into their own teaching style. From my interpretations, this way of using informal science may come with maturity and experience for some teachers – especially when they are already drawn towards science. Vicki may simply not have come to that point in her career. The ways that five of the six teachers describe using informal science is supported by Michie(1998) who found that teachers mainly took field trips so their students could benefit from the hands-on, real life experiences and by Mullins (1998) who found that teachers became involved in outdoor field experiences because they value interactive learning and real-life projects offered by informal science sites. Good science teaching involves an inquiry-based approach where learning is through direct experience with materials; and books, experts and other resources are constantly consulted (National Science Foundation, 1999a). Informal science sites are ideal places for this kind of approach to science teaching. As one university faculty member stated, "The museum is a natural setting for inquiry" (Middlebrooks, 1999, p. 31). Suzanne's comments reflect this when she says, "That's where it's all happening! I mean, what can you do in this little room? You can do a lot. But you can do a lot in here and a lot out there [in the community] too."

The Value of Informal Science

While most of the teachers in this study have similar reasons for using informal science in their teaching, they valued different things about the resources that informal science sites have to offer. This is difficult to separate from *how* they use informal science because they use it for the things they *value* about it. Understanding the different importance these teachers place on informal science resources can assist museum educators in designing their programs, materials and other resources so that teachers may come into working with their site through many different avenues. In Chapter Four, I described each teacher participant in a case-by-case format. In order to clarify how differently these teachers use informal science and the different values they place on it, I used a one-sentence descriptor for each of them. These individual themes emerged from the interviews, observations and documents related to each teacher. Below I relate the literature to these different values that the teachers place on informal science.

Informal science is the bridge to the world for her students.

Suzanne believes that it is essential to a child's education that they feel a connection to where they live – to their home, to their neighborhood, to their city and to their planet. As a kindergarten teacher, this is something that she strives to instill in her students. She wants them to feel a sense of belonging so that they will want to be involved in their community and protect the environment. As a kindergarten teacher and self-proclaimed life-long learner, Suzanne's reasons for using informal science are not surprising. Many kindergarten teachers may be strongly interested in community-based learning; but, due to science anxiety, it is unlikely that there are as many that have a strong interest in teaching science (Schoeneberger and Russell, 1986; Tilgner, 1990).

Suzanne's environmentally-focused reason for using informal science is supported by Mullins (1998) in which teachers reported that one of the reasons they used outdoor informal science experiences was to "engage students in an environmental perspective change." Mullins study had a strong environmentally-based science education focus to it and the teachers in her study tended to have an environmentally based approach to their teaching. Similarly, Suzanne stood apart from the other teachers in this study in that she was more environmentally focused and was especially interested in biology.

Informal science is a treasured gift of science experiences.

Betty values informal science sites for their inherent unique qualities. During our interviews, she uses the word “love” several times to describe her feelings towards museums and nature centers. She also refers back to her role as *mother* many times in talking about her decisions to use informal sites in her teaching. She says,

> That’s what I had done with my biological children. I knew how much they had gotten out of it. So when I started teaching, I took them to all these things because it felt right. Because I knew it’s what they needed.

Betty’s love of museums is echoed by Hein and Alexander (1998).

> Perhaps it is precisely *because* museums are informal learning settings, where attendance is voluntary and meaning not prescribed, that they are so loved. In a museum, the visitor may wander at will, lingering here, breezing through there, taking in those things that connect to prior knowledge and experience, and discovering new ideas with delight (p.42).

Interestingly, the value that Betty places on informal science is the value I thought that most of the teachers in this study would equate with informal science. This was obviously not the case. While they may have appreciated the inherent qualities of museums, they used the resources of informal science sites for much different reasons. This reinforces the finding that not all teachers use informal science for similar reasons.

Another reason why Betty says that she uses informal science is for the specific benefits to her at-risk students. This further reflects her emphasis on her motherly role in her approach to teaching and her *gift of science experiences* to her students. She explains this.

> What a child chooses to do depends a lot on what you've exposed them to when they're little. And it's not necessarily going to come out of what they're exposed to in the schools. I found out that generally that's not the case. It's these other outside things that you expose them to that's so important. So, I guess the parents don't do it so I feel like I have to do it as a teacher.

Mullins (1998) and Russell (1997) also reported on the benefits of informal learning experiences for normally low-achieving students. Like Betty and Greg, the teachers in Mullins study expressed how students who normally did not participate in class activities and had difficulties academically, often enthusiastically participated in informal projects where they could share their expertise or do something with their hands. The other teachers in this study did not teach at low-income schools and they did not emphasize this as a reason for using informal science as Betty and Greg did.

Informal science serves as a partner in providing students with challenging opportunities in science.

Joe enjoys working with other people in the community who are as interested as he is in bringing challenging science learning opportunities to his students. Like Greg, he prefers to work on longer-term projects and his involvements provide ideal partnership examples as described in the literature (e.g. Munley, 1991; Hirzy, 1996; Robertson, 2001). For example, in the past, he partnered with the Nature Center on a study of ponds and then his class decided to extend this to the study of their own school pond where they partnered with the Watershed Protection Department in order to learn how to preserve the pond. He looked to the resources of the community in order to inform their project. In addition, he would prefer not to involve the whole grade level or school in his projects. He feels that he has more freedom when he does not have to involve other teachers, who he says tend not to be as committed to these kinds of projects. And unlike Greg, he tends to involve himself in multiple projects with different individuals.

From my own interpretations, teachers like Joe are even less common than other teachers who enjoy teaching science and seek out informal science resources. He is a leader in science education and involves himself on many levels. He says that he enjoys what he does inside the classroom and outside the classroom with science. Joe says that constructivist-based science teaching and learning is what keeps him interested and stimulated. Once again, flexibility on the part of the museum (Hirzy, 1996) is paramount in working with teachers like Joe. He would much rather work on an in-depth customized project with an informal partner at school, than go on multiple pre-programmed field trips to different sites.

***Informal science sites are science laboratories for class projects*.**

> I am using them [Nature Center] because they are just like a laboratory to me. We don't go there and they put on programs for us. We go there to use their site because they have this water facility.

Similar to Joe, Greg values informal science sites for the opportunities it allows he and students to conduct their long-term science projects. Yet, unlike Joe, Greg places value on one "thing" that Falk et al. (1986) referred to when they pointed out that the "things" of informal science sites are what often makes them unique. The Nature Center provides his class an ideal outdoor environment. Similar to Kathryn, Greg values the resources they provide and like her, he seeks out their expertise. Yet, unlike Kathryn, he tends to work with one site and does not draw on its educational programs. Greg is involved in a funded partnership with an informal science site. In becoming involved in this partnership with the Nature Center, Greg says that they are simply the ones who provided the funding and had the facility. Unlike Kathryn, he did not express any real appreciation for the site or informal science sites in general. He was more focused on their class project and the reality of providing his students a unique learning opportunity. According to Greg, the fact that the Nature Center has a "water facility" is why he continues his project there. He and his students have their own plans for their class project and did not depend upon the Nature Center to supply this. He simply valued having a "place" or "laboratory" to conduct his project. It was therefore important that the Nature Center be open to Greg's ideas and to let him take the lead.

Outdoor informal science sites, like the Nature Center, may be more likely to serve as "laboratories" for teachers and students because there is not likely a predetermined purpose for these natural areas except for education in general. Teachers like Greg may therefore look to these sites to provide the context for a class project. A suggestion to these sites might be that they have the flexibility to offer and encourage the use of their site in this way.

Informal science is an essential resource for teaching science and growing professionally.

Kathryn values informal science because it is an essential *resource* for teaching science and growing professionally. She says that in deciding on her use of informal sites, she asks, “What do they have that I can use in my curriculum? It’s not really, what is their program? It’s more, what do they have?” Kathryn defines some of these resources as physical or live objects, in-depth content knowledge by the staff, and on-going research projects and specific exhibits. This is supported by Russell (1996), who stresses the importance of maintaining interactive exhibits, educational materials and science equipment that teachers often do not have access to at their schools. Teachers like Kathryn will seek these kinds of resources out. One resource that is particularly important to Kathryn is the content expertise of the informal science staff. Interestingly, there is little in the literature on the value of this resource to teachers. Kathryn has years of experience as both a teacher and a frequent user of informal science. Most teachers are not likely to have had this depth of experience. From my own interpretations, Kathryn uses informal science in an “experienced science teacher” way. This is supported by Michie (1998) who found that as teachers gained teaching experience, they felt they led more effective field trips. After 29 years of teaching, Kathryn knows just what she needs from these sites to either plan a field trip or use another resource in her teaching. She said that when she first started teaching, she would just “go and listen”. This “novice approach” to leading field trips is natural and as Mullins (1998) points out, these novice teachers are often not very reflective about the field trip experience and are more focused on superficial elements of the trip. Novice teachers may therefore be less likely to look for ways that an informal science site can benefit them in terms of resources

***Informal science experience provides a strategy for teaching science*.**

Vicki stands out distinctly from the other teachers in this study in terms of how she and her students have benefited from working with museums. She does not actively seek out informal science resources nor does she "go the extra mile" like the other teachers to ensure that her students experience the benefits of informal science. Vicki says that she learned how to teach science through her summer work with the Children's Museum. She says that her science methods course in college emphasized discovery learning and she always felt that there was something missing. She claims she never saw the science behind the activities they were doing. She felt she lacked the skills to teach science. In contrast, Vicki explains that she learned how to do real investigative science where the students explore their own ideas and follow an inquiry approach. She says that she felt more confident in her ability to teach science after her experience with the museum. This is echoed in a statement made by a teacher intern at a museum,

> That experience affirmed for me the value and importance of inquiry-type experiences for young people. I've seen that when the expectation and the opportunity are there, then all kids are active learners (Middlebrooks, 1999, p. 61).

Vicki also says that she learned how to teach science "just with a box and with whatever was around" from working at the museum. Before this, her classroom was not very science-oriented because she did not know how to teach science. Her experience with the Children's Museum likely gave her the tools and the confidence. A supervising teacher of a preservice teacher intern at a museum said the following:

> The science center experience helped provide my student teacher with confidence in teaching hands-on science when most beginning teachers are just trying to get through the curriculum (Middlebrooks, 1999, p. 63).

Due to her experience with the Children's Museum, Vicki also says that she now feels more comfortable planning field trips to other sites and calling on other informal resources to help her in her teaching. Middlebrooks (1999) supports this when she lists this as a benefit of museum-university partnerships. Having been exposed to informal science resources, student teachers realize that there are community resources available to assist them.

The value that Vicki has placed on her informal science experiences supports the literature on the benefits of university-museum partnerships in preservice teacher education (e.g. Kelly, 2000; Martinello and Gonzalez, 1987; Middlebrooks, 1999). And while claiming that museum educators have the necessary skills or training to educate preservice teachers on how to teach science is far-fetched, there may be much to be gained from a collaboration between university educators and museum staff on helping teachers feel more confident in teaching science. Vicki's experience with informal science is something that I did not expect to find in this study, and adds interesting complexity to the ways in which teachers have benefited from their use of informal science.

Why These Teachers Use Informal Science: Summary

The teachers in this study emphasize the importance of informal science to their science teaching. Based on my interpretations, it serves as a natural extension of an inquiry-based, constructivist approach to teaching for these teachers. In addition, they all have a strong passion for science –some reflect on this directly while others do not. But it is clearly an important factor in their choice to use informal science. As Suzanne clearly states, "You do what you love." While these teachers shared important reasons as to why they use informal science, they varied greatly in terms of what they specifically *value* about informal science, and this, in turn, affects how they tend to use informal science.

How These Teachers Use Informal Science

While most of the teachers in this study share some of the same reasons for using informal science – mainly as an extension of their science teaching - they vary greatly in *how* they use informal science. This is related to what they claimed to *value* about informal science. How they use it varies along a continuum of emphasis on *partnership projects* to *multiple field trips*. While they are all dedicated elementary teachers with a strong interest in science, there is not "one way" that these teachers tend to use informal science sites.

Interestingly, there is little in the literature on how teachers are using informal science. Russell (1996) and Ramey-Gassert (1997) both describe the availability and benefits of using the resources of informal science sites beyond the field trip, but do not address *how* teachers are using these resources. The museum education literature focuses almost solely on creating formal partnerships between the informal community and schools (e.g. Hirzy, 1996; Munley, 1991; Robertson, 2001; Russell, 1996, 1997; The Franklin Institute Science Museum, 1992). In this study, only Greg is involved in a formal partnership with an informal science site, and it is a highly customized program that involves only his class and the Nature Center. While many of the other teachers in this study have been involved in partnerships with informal science sites in the past, it is not the primary way they use informal science.

Based on my interpretations, it may be wise to question the notion that partnerships between informal science sites and entire schools or school districts is the best route to take in encouraging the use of informal science. Many times, these partnerships that develop are actually agreements where the school or school district sends all of one grade level to a particular site for a certain programmed visit. Ultimately, this can result in it simply becoming the "one-time field trip." While visiting an informal science site on a one-time trip can positively affect many students, the teacher's involvement in making decisions is often low. For example, I observed Joe on a field trip to a water treatment plant that was sponsored by the city and designed for all of the fifth graders in the district. The teachers' level of involvement was very low, including Joe's. He had little choice over what they would be doing and the staff at the water treatment plant led the students on their content-based field trip. Based on what is considered a successful field trip (e.g. Griffin and Symington, 1997; Koran et al., 1984; Mullins, 1998; Orion, 1993) – pre-visit preparation, integration into an existing curriculum unit, process orientation over content, time for interaction and post-visit discussion – this would not have ranked very high. The teachers were more involved in controlling the behavior of their students. According to Griffin and Symington (1997) this behavior management is typically what most teachers do on field trips – whether they are part of a museum/school partnership or not. Most educators would agree that this is not the ideal partnership that the literature refers to. Yet, it is likely how some of them ultimately materialize.

In contrast, the type of partnership that Greg is involved in is one where he and his students make most of the decisions. An important component, then, of any successful partnership between museum and schools is that the level of teacher involvement remain high. Lessow (1990) found that teachers took more field trips when they felt they had more control over it. And as Griffin and Symington (1997) point out, when teachers have little role in planning field trips, they tend to use it less effectively. In a review of successful museum-school partnerships, Hirzy (1996) reported that an important key to a project's success is the recognition that teachers want freedom of choice. They look for a variety of teaching options rather than a pre-determined tightly organized plan. And in a description of a successful partnership, one museum educator found that "the recurring theme among teachers was choice. The next time I develop a program, I will include many resources which allow teachers the freedom to choose" (Hirzy, 1996, p. 51).

Many of the teachers in this study have been or are currently in more creative partnerships with an informal science site in which they have more control. For example, Joe, Vicki, Greg and Betty have all partnered with an informal science site to participate in Science Fun Day. They prepared projects and booth presentations with the help of their informal science partner site that the local community could share in. These sites offered their subject expertise, equipment and other resources to help with the project. And these partnerships were between individual teachers and informal science sites. Based on my interpretations, it is not the *idea* of a partnership between an informal science site and an entire school or school district that is faulty, but the tendency for teacher involvement to be relatively low. In this study, the partnerships that worked best were those where the teachers' level of involvement was high. There are indications that there is increasing realization that teachers make a significant difference in whether partnerships between museums and schools materialize. One museum educator stated this clearly, saying,

> Going into our project, our focus was how best to teach children. Now I know that we've got to begin a dialogue with the right audience: the teachers. If they believe in our exhibit and our programs, they will bring the students; if they don't, they won't (Hirzy, 1996, p. 29).

Teachers themselves also recognize this. One teacher who had been involved in a project with a museum offered this advice,

> Find teachers who are interested in the partnership and have a stake in seeing it though. In our case, the museum staff was equally dedicated. The fact that we all listened and shared ideas and concerns made this project work (Hirzy, 1996, p. 29).

This teacher's statement is further supported by Hirzy (1996) who stated that teachers are the key influence into the development and maintenance of partnerships between museums and schools. And as Stec (1993) states, "A major link in the communication between schools and museums is the classroom teacher." (p. 23) Maintaining a flexible relationship, where a teacher is able to take more of a leadership role, is an important component of these partnerships. Greg's involvement in a funded partnership with an informal science site is the type of relationship between a school and an informal science site that is described by Hirzy (1996), Robertson (2001) and Munley (1991) as being ideal. Greg's relationship with the Nature Center is supported by the school district in conjunction with additional outside funding. Each partner is committed and contributes both time and resources. Greg is clearly focused on their class project and the reality of providing his students a unique learning opportunity. It was therefore important that the Nature Center be open to Greg's ideas and to let him take the lead. This requires flexibility. Hirzy (1996) lists flexibility and experimentation as one of twelve conditions for success in forming museum and school partnerships. If the museum staff had insisted on developing its own programs to meet the needs of the Greg's class, the partnership would not have been successful.

While partnerships can be an ideal way to bring the benefits of informal science learning to students, an important finding of this study was that not all of these teachers are involved in partnerships with informal science sites. While they are considered good science teachers who use the resources of the community in their teaching, there is not *one best way* that they did this. A recommendation based on the findings of this study would be that the informal science community emphasize *multiple entry points* for teachers. The teachers in this study decide to use informal science sites based first upon their interests and personal teaching style and secondly upon the kinds of support they receive. These teachers rely on field trips, the expertise of museum staff, books they bought at the museum store, teacher workshops or school outreach programs as tools in their teaching. And while, as Sheppard (1993) asserts, the school field trip remains at the heart of a museum education experience, the different ways that teachers use that trip and the frequency they take them needs to be more fully recognized. Ideally, that trip is not a one-time event, but an important part of a curriculum unit or the beginning of a partnership project with a museum.

Some teachers may seek out project-based partnerships like Greg, but others may prefer to use informal science sites more as a resource in their teaching and professional growth, like Kathryn. Still some others may prefer to use multiple sites more as extensions of their classrooms, like Suzanne, and may not actively seek out museum educators. One teacher may appreciate the wide variety of teacher workshops offered by a site while another may take advantage of the fact that the site can work with an entire grade level on one visit by breaking the group up for different activity sessions with volunteers. One teacher may want to develop a customized field trip program with a museum educator for her students on coral reefs, while another would like one of the museum educators to bring their coral reef program to the school for their Oceans Week activities.

So what does this mean for the average elementary teacher and the museum educators wishing to serve them? Unfortunately, most teachers are not as passionate about science as these teachers are. Using informal science may not be a natural extension of their science teaching. Yet, I believe that knowing something about how these teachers are able to accomplish this can inform this issue. Support – from administration, other teachers and parents – is obviously important to these teachers and is likely to be even more important to other teachers. In addition, simply by encouraging those teachers with a strong interest in science to use informal science is likely to impact far more students that their own. The teachers in this study are the “field trip planners” and initiators for their grade level, and many of them for their school. For example, Suzanne’s desire to visit many sites impacts her entire grade level because they all go on these trips. And Kathryn and Joe have brought in many interesting school-wide science projects that they have been a part of – such as Kathryn’s global weather data collection project.

I believe that it is also important for museum educators to recognize the many different needs of teachers. For example, based on these teachers’ descriptions, the education director at the Nature Center was a good example of someone who acknowledged when it was time to provide programs for teachers and when it was time to allow a teacher more flexibility and control in planning their trip. Many teachers will want – and need – the programs provided by museum staff and it is the staff’s responsibility to design thoughtful curriculum in conjunction with involved teachers. Other teachers – like the ones in this study – will be more active participants and want to design their own program or project. I believe that many sites are not amenable to this and this is likely to discourage teachers such as those in this study from returning. Teachers such as these will want to use informal science resources in different ways. In order for informal science sites to work with them effectively, they must be flexible.

Because each teacher is an individual and has his/her own unique teaching style, there may not be an ideal way for teachers to use informal science in their teaching. And interestingly, before beginning this study, I had thought that many of these “good science teachers” would be using informal science sites in much the same way – in some type of partnership capacity. This is also what the literature has focused on. Although this is an in-depth study of six teachers’ use of informal science and should not be used to support broad generalizations, it does inform the notion that there is no single prescription for effectively using informal science in teaching. Further, we need to look beyond the effective field trip as emphasized by Griffin and Symmington (1997) and others, and focus more broadly on the *effective use of informal science.* Based on the findings from this study, I would suggest that we begin and end with the *teacher* and how he or she will incorporate informal science into their approach to teaching science. The teachers in this study indicated that informal science was a natural extension of their teaching and was not something separate or ancillary. Focusing on an effective one-time field trip does not take into account the many ways that teachers can use informal science.

Support For Using Informal Science

Discovering how and why these teachers continually use informal science was the main focus of this study. And directly related to this is the *support* they receive for using informal science. An important finding of this study is that the presence of support is essential to whether these teachers use the resources of informal science for the benefit of their students. This support can come from principals, districts, other teachers, parents and a teacher's own family. Where it comes from can vary greatly among teachers. Yet, it is important that they have support. This can have profound effects on less experienced teachers. Mullins (1998) found that a teacher support system, either from peers or administrators, makes the difference in whether a novice teacher chooses to pursue informal science opportunities.

A large part of the required support for using informal science is funding. This is especially the case for taking students on field trips – which is the primary way in which these teachers - and most other teachers - tend to use informal science (Inverness Research Associates, 1995). The cost involves money for transportation and money for entrance fees. A school (or most often, the school district) allots a certain number of field trips based on priorities and what can be afforded. These costs can be huge obstacles to teachers' use of informal science. Teachers cited transportation costs as a major limiting factor to using informal science in studies by Lessow (1990) and Michie (1998). Yet, these two studies focused on teachers who did not necessarily use informal science on a continual basis. The teachers in those studies were accompanying their grade level on their allotted yearly field trips.

Interestingly, the teachers in this study do not directly refer to money as a limiting factor. I had thought that this would be a major issue before beginning this study. Kaspar (1998), in his survey of administrators and teachers in regards to the use of informal science, also found that more experienced teachers did not list administrative tasks and logistics as barriers. And like Michie (1998) and Lessow (1990), Kaspar (1998) found that less experienced teachers cited these as major barriers. Based on my interpretations, the teachers in this study are experts at navigating these barriers. While funding is always essential to their use of informal science, these teachers talk more about the *source* of the funding. Based on the teachers' stories, and my own interpretations, they are more concerned with the emotional support they receive from these sources. My interpretations are that they know that funding will often follow – or they can at least find a way to raise the money if they know there is enthusiasm for engaging their students in informal science opportunities. Betty is a good example of this in that her principal has a strong impact on whether she is able to do as much hands-on science and informal science with her students. Due to the fact she teaches in a low-income area, it has not been easy for her to involve her students in a multitude of informal science experiences. They only take the predetermined set of field trips and cannot afford to ask the parents for extra money for more trips or projects. Yet, having her principal's support – and to take this further, her *encouragement* - has made a big difference in her motivation for seeking out informal science resources. This encouragement has come in the forms of verbal encouragement and a promise to help her find money to take an overnight field trip. In the past, her principal has also helped her find partners to work with on interesting projects and provided her with grant information. When she has not had this kind of encouragement from her principal, Betty has found it difficult to pursue informal science activities.

This importance of administrator support is reflected in Mullins' (1998) study where a lack of support by the school administration was one of the most frequently mentioned obstacles to taking field trips. This is further supported in a statement made by an experienced teacher who uses informal science regularly in her teaching.

> Those teachers have to somehow have an administration that understands that a field trip is not just kids getting away from school, it's not a play day. The administration has to understand that it is an extension of the classroom. Five hours on a field trip can be worth far more than five hours in the classroom. Administrations and school boards have to be able to see how field trips can positively impact grades and see that it's okay to be different (Mullins, 1998, p. 134).

Further, administrative support has been described as being extremely important to teachers' ability to effectively teach science (National Research Council, 1998; Ramey-Gassert et al., 1996; Texas Statewide Systemic Initiative, 1999). District and state current policy on science education likely effects some teachers' use of informal science. This is especially true for Betty, who expresses how the de-emphasis on science and focus on passing the state standardized tests has hindered her teaching of science and use of informal science. None of the other teachers expressed this same sort of frustration. Teaching at a school in a low-income area where passing the tests was of major concern was likely an important factor. While Greg also teaches in a high-poverty school, he is somewhat protected due to his district-approved and specially funded science-focused classroom. Without administrative support of some kind, even a highly motivated teacher will find it difficult to do the things he/she would like to do with students in science inside or outside of the classroom.

Administrative support, whether from principals or school districts, is discussed as an influencing factor in these teachers' ability to use the resources of informal science – although to varying degrees among them. A teacher in a small school in a large district relies heavily on principal support, while another in a large school in a smaller district relies mainly on district level support. It is also clear from Betty's and Greg's experiences, that administrative support is likely to be especially important for teachers in low-income areas. Without district support of his Young Scientists program, Greg would have difficulty involving his class in such an extensive off-campus project with an informal science site. The success of that program has largely been due to the collaborative nature of its beginnings and the community encouragement it has received. And Betty clearly is unable to use informal science extensively when there is a focus shift away from science at the district and state level. And her principal's encouragement is needed for her to pursue her science teaching goals. Several other teachers spend little time discussing administrative support of their informal science activities. While the fact that they do not discuss it does not necessarily mean that it has not been an important factor, it is a factor that they may have taken for granted. This is especially the case in the higher-income schools where there tends to be more parent support for these trips and projects – especially in terms of funding. For example, at Kathryn's school, the district and school encourage the many projects and trips, and have given control to each grade level to decide their activities.

Parents, in turn, are able to financially support these projects and trips and since many mothers work at home, they can act as chaperones.

Surprisingly, there is little in the literature on the importance of parent support in teachers' use of informal community resources. The studies of teachers' use of informal science tend to focus more specifically on the field trip and not the teachers themselves (e.g. Lessow, 1991; Michie, 1998; Mullins, 1998). Further, those studies focus on either experienced science teachers from all levels of education (Mullins, 1998) or on more typical teachers on a grade level field trip (Lessow, 1991; Michie, 1998). Yet, parent support was found to be a significant influence on all of the teachers in this study. As Joe says, the amount of parent support "makes all the difference." From my own interpretations, parent support was found to be important in this study because these teachers are the ones *planning* the field trips and projects. This is not necessarily the case in the other research studies mentioned above. The teachers in this study are passionate about science and want to seek out community resources and unique opportunities for their students. They realize the important role that parents play in making that happen – in terms of both financial support and emotional support. When parents are not able to contribute as much due to financial limitations or work schedules, those teachers rely more heavily on administrative and outside support and must harder to provide informal science experiences for their students.

Because the teachers in this study are often responsible for planning the field trips for their grade level, many of them express frustration at the negative attitudes of other teachers towards project involvement and science in general.

With the possible exception of Suzanne, who has a few supportive, enthusiastic kindergarten teachers she works with, the other teachers indicated that they were the only (or one of a very few) science-oriented teachers at their school. Support from other teachers was another level of this theme of support. While Suzanne and Kathryn mostly benefited from teacher support in their use of informal science, the other teachers did not. For example, Joe explains his frustration with other teachers:

> There are teachers that I teach with that are interested in science, but it's kind of like, "Well, tell me what to do and I'll do it. " So again, it's the pulling people along thing. If I had time to do it, I'd love to do it. But setting meetings and arranging….It's just that I don't want the fun in it to be diminished by having to deal with things by committee. I would love to work with somebody on Science Fun Day, but nobody really wants to do that sort of thing. When we do things in school as part of our curriculum, we share resources and things. That works out fine. But generally, when we talk about informal science, we're talking about above and beyond.

This sentiment is somewhat supported by Michie (1998), in which teachers reported some antagonism from other teachers if they took students on field trips. Yet unlike this study, in Michie's study, the students were in secondary school. The teachers complained because students were taken out of class or were late for another class. Based on my own interpretations, the teachers in this study are experienced, science-oriented, curious teachers. And unfortunately, they are not the norm in the teaching profession. They are more like the teachers in Mullins (1998) study, even though those teachers were mostly secondary-level teachers and college professors. They were clearly passionate about teaching science. Mullins (1998) found that the more experienced teachers reported *fear* within the teacher to be the most significant obstacle to teachers implementing field trips. One teacher said,

> It's just not familiar. Teachers need someone. They're afraid of the unknown. You're likely to do things the way you've always done them unless you have some good reason to do something different…like if there is a real good program and someone suggests field trips and they take teachers out, and then teachers say, "Oh, that's not so hard, I can do this." Teachers want to, they just don't know what to do because we do so little of this in our teacher training programs (Mullins, 1998, p. 136).

While the teachers in this study have ultimately been responsible for their choice to use informal science in their teaching, they are the first to admit that it has required plenty of support – financial, logistical and emotional. All of these teachers claimed to *require* support to use informal science. It is not something they can easily do on their own. As evidenced in Chapters Four and Five, these teachers are excellent at "navigating the barriers" in terms of their use of informal science – whether it is simply rallying parent support despite a lack of funds, holding bake sales, or finding ways to bring informal science *into* their classroom. And if these teachers, who are clearly exemplary science teachers, require support and encouragement, then it is likely that other teachers need even *more* encouragement in using informal science. As mentioned earlier, the average elementary teacher is likely to feel apprehensive about teaching science, and will lack the confidence needed to seek out informal science opportunities. I believe that the average teacher needs to first have the funds and transportation available. The exceptional teachers in this study often found this on their own – it was the emotional support that they needed in order to continue the pursuit of their science teaching goals. Based on my interpretations, providing more support for teachers in using informal science is a logical place to begin to focus energy so that more teachers are likely to look to these community resources.

SUGGESTIONS FOR FURTHER RESEARCH

The findings of this study have provided some insight into the possibilities of connecting more teachers with the resources of informal science. Yet, in order to more fully address this issue, we would need to hear the perspectives of those teachers who are *not* extensive users of informal science. A naturalistic inquiry study of teachers who go on regularly scheduled field trips *only* in which their perspectives on science teaching, their background in science and their approach to teaching in general are addressed would greatly inform this topic. Based on my review of the literature, the perspectives of teachers are greatly needed in this field.

Another natural extension of this study would be to investigate the relationships between the formal school system and informal science sites. Hearing from museum educators on their perspectives regarding teachers and their relationships with the schools would inform the issue of connecting more community resources with schools.

CONCLUSION

It is my hope that the findings of this study of teachers who have regularly used the resources of informal science can inform the topic of creating more lasting relationships between the informal science community and teachers. When I began this study, I had assumed that the teachers in my sample would be using informal science in more "partnering" ways simply due to the fact that they use it regularly. I found that there are many unique ways that a teacher can use the resources of informal science in both their teaching of science and for their own professional growth. Both the formal and informal education communities have tended to focus their efforts on creating more formal institutional partnerships. While these can indeed be valuable and highly desirable, this is not the only way that teachers can effectively use the resources of informal science. The teachers with whom I spoke all valued informal science for very different reasons, and yet they also shared many characteristics - perhaps most importantly a passion for teaching science. Creating lasting relationships between teachers and the informal science community will require more than looking at institutional issues. It will require consideration of the unique needs of the individual teacher. This also means that informal science educators will need to seriously evaluate what it has to offer teachers so that teachers feel that they have a variety of options in using informal science. And museums and schools will need to provide more assistance and support in teachers' use of informal science. It is my hope that I have provided some insight into the ways that some teachers have managed to incorporate informal science into their teaching, so that administrators, museum staff and teachers themselves can help foster these relationships.

Appendix A
Researcher as Instrument Statement

I am the research instrument for my study. It is therefore important for myself, and the readers of this study, to recognize and understand my beliefs, values and expectations as they pertain to this research. I will explore these issues as they relate to my interest in researching teachers who frequently use the resources of informal science. My basic question is “Why and how do these teachers continue using informal science?”

I see myself as both a biologist and an educator. I fell in love with biology as an undergraduate. This was my first experience in “outside” classrooms; meaning, we didn’t simply study animals and plants from a book as in high school, we were able to see them as they are. We looked at organ systems, and studied anatomy by exploring the real thing. This was amazing to me, because as a child in public schools, almost all of my learning was from a textbook. We rarely went on field trips, and my appreciation for nature came only from my family’s regular camping trips. I feel that I was denied the experience of hands-on learning as a child in school. I was a product of the “Back to Basics” movements of the late 70’s and early 80’s, where inquiry learning became obsolete. In fact, I cannot recall any science teaching in my elementary years – except for the yearly science fair competitions. So it was not until college that I discovered my love of the study of nature. I wondered, “ If I had had the opportunity to really *see* science in action as a child, this part of me would have been tapped into along time ago.”

Appendix A *(continued)*

I don't wonder about this because my grades were poor; in fact, I always excelled in school. It was more a matter of interest and depth of learning. I felt cheated; I had limited access to good teaching. And yet, somehow I had enough interest in science to make it to graduate school, where my passion for studying nature could be fulfilled.

I am also an educator. I have always felt that when I am teaching, I am doing my best work. I remember as a museum educator teaching a program on insects, where my short stories about the interesting behaviors of bugs could light up a child's eyes – especially once I let one crawl up a child's arm. I know that if teachers create initial interest in a topic, the rest of teaching and learning comes easily. This is where I see museums (and nature centers, zoos, etc.) playing an important role in student learning. It is "informal" learning- meaning, there are no guidelines on what you should be learning, and no tests before you leave. It is hands-on learning at its best, and museums have many resources to offer teachers. As a child, I only went to museums with my family on out-of-town trips. These trips stayed with me, and I still remember the wonder I felt as I explored the galleries and exhibits. But many parents do not consider taking their children to museums. For many children, their only exposure might come from a field trip. Working as a museum educator, I saw the advantages of bringing students back to the museum on return visits with their classes. I witnessed the enthusiasm of an 8 year-old boy who was having trouble in school as he asked if he could see the worms again to see if they really had eaten the leaves in the compost bin. All children should have the right to learn to their fullest potential. I believe it is not only the responsibility of the parent and teacher, but the community as well. Museums have so much to offer, and it is a shame if it is only available to a certain few. I want to take good science teaching to all children. I worked in a museum where only the children from more advantaged homes came again and again. There was no outreach to other children – through their families or schools.

There is another driving force behind my interest in this topic. It has to do with people's attitudes about science – specifically how teachers feel about science and their ability to teach science. With my first biology course in college, I had an incredible teacher who was amazing at creating interest. I studied hard and did well, I felt I could "do" science. That was it. It basically took one good teacher to tell me I could do it. Yet, as a woman entering the field of science, I found that it was often an uphill battle. There was one particular professor who made it very clear that he thought the men in the class were more likely to succeed in science careers. He commented on their brilliant answers, and made them feel a part of the "good old boy" network. When I asked a question, he would put his arm around my shoulder and speak to me in a very patronizing manner. In many of my other courses, I noticed the women tended to have to prove themselves in the field of science. I remember consistently making better grades on exams and papers, but the praise was always focused on the men in the class. There was more expected of them in terms of their futures. I believe this gender-biased attitude is slowly changing, but the exclusiveness of science studies still pervades.

My clearest example of this exclusivity was as a graduate student in zoology, when I was a teaching assistant for a professor for a non-majors course in biology. A great many of these students were planning on careers in teaching, and this was there only exposure to biology in college. The professor presented the material in a very dry manner and simply lectured to the students. She made it very clear to me who she thought was not worth teaching to. Her students felt this as well. Many of them voiced their fear of science to me. The professor reveled in this, and felt that it was appropriate if the students felt her class was intimidating. She would say, “I don’t like teaching this class, only a very few have any interest in science”. She could have taken the challenge to try to foster an interest. Instead, she helped instill a lifelong fear of science in these future teachers. I don’t think those teachers will be too enthusiastic about teaching science to their students.

Elementary teachers are required to teach science; and yet, most of them lack confidence in their abilities to teach science. I strongly feel that informal science institutions, like museums, can address some of this. Just as the children come in and let their minds wander; teachers do the same. They deserve this opportunity. By working with museum staff, they can participate in professional development for themselves and gain confidence in teaching science.

Appendix A *(continued)*

I come from the museum world and the research biologist world. I have never taught in public schools; although I substitute taught in middle schools for awhile. I have total respect for teachers. I believe it is the toughest, most important and most undervalued job there is. They should be paid twice what they are now making. I can even sympathize with the many teachers who have been "beaten down" by the bureaucracy of the schools - after entering teaching with such enthusiasm. The teachers that I believe are truly exceptional are those who have stepped outside of the system and really "do their thing" of real teaching. I have seen and worked with these teachers in my experience as a museum educator; I want to know how they do it.

Most teachers obviously do not use museums (and other such places) for their own professional development, or for their students on a regular basis. But there are some that do. I have some beliefs about why many teachers are not able to use museums more. For one thing, I think the heavy bureaucracy of the schools does not allow for it. There are too many details and mandates that teachers are responsible for. I also believe that in the midst of all of the standards, paperwork, new curriculum and testing, many teachers lose sight of why they went into teaching in the first place – to teach. There isn't even enough time to do their primary job. Another reason I believe teachers may not be utilizing museums is because they never frequented museums as a child – with family or school. They may also simply not be aware of what museums can offer them. Lastly, I have a feeling that many teachers are uncomfortable with science in the classroom; and they certainly would not look for it outside of school. It is not that they do not think their students would benefit; I believe it is simply due to a lack of confidence in teaching a subject they are uncomfortable with.

I hope to find that those teachers that do utilize museums have strong support from their principals, and that the museum staff work closely with them to meet their needs. I have a feeling that some of them may have to be "uncanny rebels" in order to make it happen, especially when they lack support from their schools. I hope to find that they feel more confident about their science teaching ability as a result of their museum experiences. Yet, I am also prepared to find that they already may have been very confident about their science teaching in the first place, and thus felt comfortable in the museum. I am unsure how I would react if I found that the teachers said they were told to utilize the museum, and they felt it was more of a burden. I cannot imagine that being the case, especially because the teachers I speak with will have been referred to me by my museum contact.

The results of this study may assist other teachers and museum educators in developing and maintaining successful relationships. Principals and other school administrators may look at this study for insight into how to encourage and assist teachers in using informal science resources. I also hope that pre-service teacher educators begin looking at ways to expose more teachers to informal science. This research could help to make this more of a possibility. This is also a very personal endeavor, in which I wish to see for myself what makes these

Appendix A *(continued)*

relationships work – so that I may help to bring good science teaching to all students.

Appendix B.1
Consent Form A

CONSENT FORM A: Participation

Teachers' Perspectives of Why and How They Continually Use an Informal Education Site

The Study
You are invited to participate in a study of why and how teachers utilize an informal science education site.

My name is Christy Youker and I am a graduate student at The University of Texas at Austin in the Science Education Center. This study is my dissertation research project. From this study, I hope to learn more about why and how some teachers continue using the resources of an informal science education site. This is especially important because we know that many informal sites have vast science resources that many teachers never tap into. This research could be of benefit to other teachers in their work and, of course, to their students. It could also benefit school administrators seeking to work more closely with museums, as well as museum education staff, seeking to better meet the needs of teachers.

Your Selection as a Participant
You were selected to participate in this study because you were either recognized as a teacher who continually uses informal science sites. You will be one of approximately 6 to 8 total respondents chosen to participate in this study.

Responsibilities as a Participant
If you decide to participate, I ask that you meet with me on approximately five occasions for approximately an hour each for open-ended interviews. I also ask that I be allowed to observe activities that you recognize as being related to your use of the informal site. I would also like to have copies of any relevant materials you think would add insight to this study. This could include notes from teacher workshops, lesson plans/curriculum dealing with the informal site (or resources provided by the site), communication with site staff, etc.. I will then check back with you after the interviews to ensure that what I have summarized matches your perceptions and experiences. I will also ask that you do a final review before the report is submitted.

You should be aware that interviews will be audiotaped and used for transcription and analysis for this report (which you will have full access to). You are not obligated to answer every question that I ask. If you are uncomfortable with the question, or wish not to pursue the topic any further, just let me know and we can move on to something else.

Appendix B.1 *(continued)*

The tapes will be stored in a locked drawer in my home. They will be destroyed after the study.

Potential Risks and Benefits

There are few known risks, discomforts or inconveniences due to participation in this study. Yet, there is always the possibility of the loss of confidentiality of your responses. I will do my best as the investigator to maintain your confidentiality (see below). In addition, because this is an interview, you may experience psychological discomfort due to the discussion of a sensitive issue. Yet, this is unlikely because as the participant in open-ended interviewing, you determine the course of the interview. The research topic itself does not directly address a controversial or sensitive issue.

As a teacher in this study, you may possibly benefit through a deeper understanding of your own teaching and of your motivations for using this informal site for your own professional growth and for the benefit of your students. If you are participating in this study as a teacher, you may also become more consciously aware of the support you receive (or don't receive) from other teachers, your school principal and/or district office in visiting this site. If you are participating in this study as a museum educator, you may come to a better understanding of your relationships with these teachers and possible ways to improve upon them (if needed) from your own explanations.

Confidentiality

Pseudonyms will be used to code audio-tapes and transcripts, and will be used in the final report to maintain confidentiality. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission.

Discontinuing Participation

Your decision whether or not to participate will not affect your future relations with The University of Texas at Austin. If you decide to participate, you are free to discontinue participation at any time. You may simply contact me (Christy Youker) personally and let me know. I would also like this in written form.

You are making a decision whether or not to participate. Your signature indicates that you have read the information provided above and have decided to participate. You may withdraw at any time after signing this form, should you choose to discontinue participation in this study.

Contact Information

If you have any questions, comments or concerns, please don't hesitate to ask. My home number is 365-8609 and my email address is cyouker@mail.utexas.edu. My faculty sponsor will also be happy to address your concerns. His name is James P. Barufaldi, Ph.D. and you can reach him at 471-7354 or jamesb@mail.utexas.edu.

Appendix B.1 *(continued)*

By signing this form, I agree to the conditions stated above.

Printed Name of Participant

Signature of Participant Date

Signature of Investigator Date

Appendix B.2
Consent Form B

CONSENT FORM B: Permission to Use Previously Collected Data

Teachers' Perspectives of Why and How They Continually Use an Informal Education Site

This study on why and how teachers use an informal science education site could be of benefit to teachers, school administrators and museum education staff looking to build stronger connections between schools and museums. Your responses to this topic will contribute to this. Due to the fact that you participated in a similar project previously, those responses are valuable as well.

By signing this consent form, you are giving me (Christy Youker) permission to use transcripts and summaries from audio-taped interviews taken in the fall of 1999. You are also giving me permission to use anything that I wrote in the final report as well as any changes or additions that I make subsequently. The present study is a continuation of that small-scale study entitled, "A Naturalistic Study of Two Teachers Who Continually Utilize an Informal Education Site" that met the criteria for a research class I was enrolled in. The data from that study relates directly to this study, and by participating in the present study, you will be asked to address the same topic. I will use these previously collected data for analysis purposes only as they relate to my present study.

I will strive to maintain confidentiality but there is the risk that it may be lost. I will use pseudonyms to code all new and previously collected data. Any information that can be identified with you will remain confidential and will only be disclosed with your permission.

I will provide you with the transcripts and summaries for you to review. I further understand that you may give me permission contingent upon reviewing the transcripts first.

If you decline to give me this permission, you should know that it will in no way affect any future relations you have with the University of Texas at Austin.

Appendix B.2 *(continued)*

You can change your mind at any time and ask that the data be withdrawn. Please let me know this by calling me at 512-365-8609. I would also like this in writing.

You may keep a copy of this form for your records.

____

Printed Name of Participant

____

Signature of Participant | Date

____

Signature of Investigator | Date

Appendix C.1
Reflexive Journal Sample

April 17, 2001
(transcribed from tape recording)

I interviewed with Vicki today. Before I forget – After I shut off the tape recorder, she gave me some of her curriculum she does regularly with her kids that is taken right from the Children's Museum curriculum book – from about 1996 or so. She helped design and worked with camps and she uses a lot of those activities, she says. She designs her stuff around using that. She said that it is her "bible" for science. She also told me that she just recently had worked on a project put on by the superintendent on doing a family parent TEKS guide. So how do the TEKS apply outside of the classroom and making sure your kids know these things. Like a family guide to this. They asked her to help on that committee. That should be done pretty soon so she said she'd give me a copy of that too. So it has to do with the science, social studies, etc. outside of the classroom. It was a pretty short interview – maybe 30 minutes. There were a couple new things she introduced – a few places she had been that she hadn't remembered before, But the ideas are pretty much the same, so I feel like I can contact her with clarifying questions, but that's pretty much it. I think we're done. She keeps bringing up the same issues and I think we've reached saturation on the topic. I noticed that with Vicki that when we begin talking about these things, she realizes she could do some of these things with her kids now. So this may be a type of authenticity. She talked about taking the kids from Fisher to the university with the parents to do astronomy. She really liked that a lot. And it was kind of parents idea to do something at night and then she found out about this and it was free. She said, "Wow – I have parents that could help with it. A few of them. We could take those that were interested." She is realizing some things she could do with her class through our talks.

Today they were busy preparing for TAAS tests next week. That was their focus. She had an intern in there today working with her and they were busy preparing sheets and working on reading comprehension things. They looked busy – not Vicki but the other teachers looked frazzled. Vicki seems relaxed. You can tell she's been doing this a while. She is a little more relaxed about things than the newer teachers.

Yesterday I participated on a panel of graduate students that were a little further a long in their grad student careers in math and science education forum. It was really interesting. It was boost for me – to feel like I have really done something already. It gets frustrating in the middle of doing this – like am I really making that much progress? So there were two others that were just finishing up their dissertations, and then there was one person who had just finished her qualifying exams and had been admitted to candidacy. And then I was one that had finished qualifying, admitted to candidacy, defended the proposal and in the middle of data collection and then there were two others who were just about to take their qualifying exams. I talked about the importance of keeping a journal and they seemed interested in that. Some of them asked me about my interviewing and observations and how I was doing it. I told them they needed to be confident in their methods and take some methods courses and read on it. I feel really comfortable that I have Dr. Lucas as my methods person if I have questions about those issues. And I feel like I've had some good reading on how to do this kind of research. Of course, now that I'm in it, it feels more nebulous. Some times I wish it had a little more structure. Just because it is so open-ended. I wonder if I'm doing it the right way and if I have enough on teach participant. I'm feeling like after 3 or 4 times of talking with them, I'm hearing the same big issues. Like today, I did get some more specifics from Vicki. But it does kind of make me nervous. I also get a sense from my participants that they are sort of tired of talking about it. I don't know if that's a good indicator – but they're kind of letting me know, "Well, I've said all I want to say about this topic." I'm going to have to push Joe some more. I don't know. He's done so much, but he doesn't seem to want to talk about it all. He hasn't really talked much about his background and interest in science –also his association presidency. Maybe I can ask him this – but he hasn't brought it up so maybe he doesn't see it as relevant. That's another tricky thing about this research strategy. I keep thinking, do I have "how they think about science", "how they feel about their teaching profession" , "their background". I might not necessarily get that on everybody. I'll go back over his interviews. I want to know WHY – what's makes them interested in doing these things.

I also interviewed with Kathryn today.. This was a phone interview, and it went really well. I got a lot of good information, and she has decided to go ahead and let me have her resume, so that I can get some information on her. She happened to let me know that she won the Presidential Award for Excellence in Science Teaching that she and Joe both have won. These are the kind of things that it's hard to get out of people. Some people don't volunteer it, so I need to remember to ask people for their resumes. She talked a lot about her professionalism and how she seeks out being in organizations and bringing scientists and teachers together. So she was talking about that… She made the comment that there's not that many people that she can talk to about all of this, because they think it seems like she's bragging or something. She said that she can talk to me about this because I'm interested in these sorts of things, and she's real quiet around her co-teacher that she teaches with because they don't think this is very cool. So I think that speaks to some of the authenticity of this and what she has gotten out of this. And it certainly makes me feel good that… You know, sometimes I feel like I'm trying to pull a lot out of these teachers and wondering if they're getting a lot out of it. It's just very rewarding to hear her say that.

One thing I want to be sure to remember is that I forgot to turn on the tape right at the beginning, so she had already started answering the first question that I asked her. The question was, "You said you often seek the expertise of outside resources, such as museums. How has your level of involvement then in informal science evolved since you have been teaching?" So that was the question. And she started out by saying that she began by just going to these place, and now she's doing things like writing curriculum. She was learning about the facilities and knowing about them, and now she has more freedom and she can customize on what she wants. But she had to go there and see about these first, and that's what she did in the beginning. I caught most of that. I just didn't actually have the question on there.

APRIL 18, 2001

(transcribed from tape recording)

I just interviewed Suzanne, Jemison Elementary in Lake Evans ISD. It was about an hour long interview today. It was really apparent from the moment I walked into her room that she is very science oriented. She is a kindergarten teacher and she has been teaching for like 23 years and she just moved to that school last year. She taught in Jonestown ISD for years. She just teaches from science. She has even written a whole science kindergarten curriculum. And she has a salamander, some fish, a rabbit or guinea pig. She has lots of animal bones. There just seems to be lots of sciency stuff in her room. It's a pretty small room. There's a lot of stuff in it – not that it looks crowded or messy or anything. It's just a kindergarten room and it looks really fun. She was really inspiring. She does a lot. She stressed the importance of the community for the kids and she really tries hard to keep that going. All of this just seems really valuable. Everything that she talks about in terms of how she is able to do it. Really just depends on your district and your principal. She said she has a really awesome principal, but the superintendent is terrible. The district in general she doesn't like. She had a lot of interesting insight into how all of that works. After the interview, she told me that she is going to the Jonestown Zoo and the Wildflower Center tomorrow. So I'm going to do the Wildflower Center with her in the afternoon. I think I need to be there at noon. I was going to do the zoo as well, but I need to be with the kids in the morning. I'll get one good observation in at the Wildflower Center. That'll be plenty. She said she has already done the teacher training so she and the other teachers get to take the kids on their own – and free. She really likes that. After the interview, she showed me all of these great pictures of the kids at museums – around the room and outside of the room. She said if I never needed any, I could use some. She also said she was disappointed with the tour at the Museum of Science and History, how they led them around. She said she could have done it. So I said, "Next time you should just do it yourself." And she goes, "I'm doing that. Tomorrow at the zoo, I'm not having anybody, because I know what I want to do anyway." She is taking more of a lead in taking her kids through there. She also was showing me pictures of people that brought things in for the kids – someone brought snakes, the beekeeper came in. She is the resource coordinating person for kindergarten.

I really enjoyed meeting with Suzanne, she is a great example of someone who is really trying to use informal science. And it made me reflect as I was printing up the proposal for her, the cover page. And I typed the title of my dissertation again. And it isn't such a good title anymore. It's changed. These teachers don't just use one site. They tend to use multiple sites. With the exception of Greg, most use different sites in Jonestown and around Jonestown. Outside Jonestown. A better title would be, "Teachers Perspectives of How and Why They Continually Use the Resources of Informal Science" They'll use it in multiple ways. They'll bring it into their school, instead of just going to these sites. So the resources of informal science I think would be a better title.

Tomorrow I'm going to get in an observation of Suzanne. So that worked out great. That way I have an observation of all my teachers except for Betty – which she said she wasn't even taking any trips anyway. So that works great in terms of the consistency of my study. I was pleased with my decision to include Suzanne in my study – it's perfect. She really rounds out my participants. I can't believe I have six. Each is different in their own way and yet they do have that common thread of using outside resources in their classroom. And a love of science. That's pretty apparent, as well.

Suzanne was considered about the district not letting them do field trips anymore or as many. I would like to try and find her some articles on the benefits of museum learning to visitors, esp. school kids. I don't think there's that many on it, but I can start looking. I think that would really benefit her. That would be something I could give back to her.

Appendix C.2
Sample Peer Debriefing Minutes

Peer Debriefing Meeting Minutes
Thursday, March 29, 2001
12:00pm
Present: Donna, Christy, Grace, & Kathleen

Donna:
Donna has been very busy interviewing will be next week at the University of Louisiana (Lafayette) and the following week at University of Wisconsin 2A (Lacrosse) Extensive 1. Donna explained the categorization of different universities but I did not get all this in my notes.

Christy:
Christy has been busy interviewing teachers and museum staff. She has had help with transcribing but doing most of it herself. She has two more participants to interview. She has completed three interviews on two participants and is beginning to reach saturation with these and feels that one more interview & observations should wrap these two up. Interviews are going well but the ways the teachers use the museums is quite different. She has second interviews with two of her participants today. Themes are emerging there is now less focus on the sites in her study and more on the teachers. She presently has four teachers and stlll feels like she needs a teacher or two. One possibility is a teacher (kinder) that takes her students to a different museum each year but she doesn't have a relationship with the sites. Christy has until the end of April to finish observations.

Kathleen:
Kathleen said she enjoyed her trip to Las Vegas and seeing her nephew who is saying DADA (she will bring pictures to the next meeting) and she got to see old friends and one who has a seven year old son that she had not met yet!

Kathleen has interviews transcribed and needs to summarize . The mid point interviews will be equal sharing problems. She has selected six case study students and has one of those that does not understand models. Two others that she plans to interview did answer the extended question. She feels that her case study students reflect a good variety of different approaches. Next week Kathleen will be in Orlando at the NCTM conference.

Grace:
Grace is making progress with her Lit. Review for her research class but she has not had any time to work on the writing up of her directed research work with Dr. Lawler. The pressure will be on about that (which she says is good ;-) if the proposal that Dr. Lawler, Dongjoo and Grace submitted to the Distance Learning conference in Madison WI is accepted. If accepted (she will know mid-April) she will have to complete a paper by June 1st. Her write up of the study for Mid-program review will be due in Oct. and she plans to take comps in the fall. She is finishing coursework this semester and plans to spend her time after this semester preparing for that.

Peer Debriefing Notes
January 10, 2002

Present: Amy, Christy, and Kathleen

Kathleen
Kathleen started by asking Amy about a conference in San Antonio in January. It's for a group called AMTE – Association of Mathematics Teacher Educators. Amy suggested that Kathleen attend the conference. Amy had a newsletter with information that she found for Kathleen.

Kathleen also asked about the form and payment you have to make the semester that you want to graduate. Christy and Kathleen are going to pay the fee this semester in case we finish writing early enough. It might push us to finish writing if we are close to meeting the deadlines.

Kathleen talked about the data analysis process. She is going to code the students' interview solutions using 3 aspects: the material used, strategy, level of model development. Based on an idea from Debbie Junk, Kathleen can look at the relationship between strategies and levels of model development. Kathleen can also use this approach to compare whether a student is using different types of strategies and/or levels of model development on different questions or over time.

Appendix C.2 *(continued)*

Kathleen had Amy and Christy look at one of the questions and the strategies. She wanted to see if the strategies fit with the actual student solutions. We looked at several and decided that she needed to add a couple. We decided that the unclassified (other) strategy selection in my database should distinguish between valid and invalid strategies. We also talked about coding both valid and invalid strategies. She can look if students are able to move to valid strategies over time.

Christy
Christy is working on chapter 4. She has finished writing the case studies for 4 out of the 6 teachers and plans to finish the last two case studies during the next week. Each case study is about 4 or 5 single spaced pages, so she has about 10-12 pages per participant. She thinks this chapter will be about 70 pages long. After she finishes the 4th chapter, she will work on the 5th chapter which will include the cross case analysis. Christy has been making notes about the cross case analysis in Atlas, so she thinks it should help her with writing chapter 5.

Christy is leaving out the data from the museums right now. She will use some of their information in the methods chapter when she describes the settings that the teachers visit. Christy will try to look at this data later, but not for her dissertation. Christy emailed her committee members and told them about this change. No one seemed to have a problem with it.

Christy also described one of her findings. She contacted Joe again to ask some follow-up questions. She did another telephone interview with him and asked why he focuses on science. Unlike the women, he doesn't talk about his parents' influence or his love of science. He is just very matter of fact about the whole thing. Christy is starting to wonder if this is a gender difference. Christy saw a similar result with the other male in her study. Kathleen suggested that Christy talk with Lynn Jones Eaton. Lynn has done research related to gender issues in science education, so maybe she can help point Christy in the right direction in terms of literature.

Amy
Amy has been very busy at work. She still has too much work to do. She is working with Cathy Brown on the Eisenhower grant in Bryan. Now they are talking about doing the same thing in Hays County. Amy is currently working on the IRB paperwork for the Eisenhower grant. Amy is also working on CAMT and the NCTM national conference that will be in San Antonio in April 2003.

Appendix D.1
Sample Interview: Kathryn Interview 1 (partial)

Kathryn
Interview 1
March 8, 2001
Miller Creek Elementary
3:00 – 4:00

(We begin by reviewing the consent form and she mentions someone at her school that might do a lot with science as a possible teacher to participate.)

Christy: So the focus of this is why you use informal science and how you're able to do that. You can start with the 'why' if you like.

Kathryn; Okay.

Christy: It can relate to science or anything else, projects…

Kathryn: One of the reasons I use like the Nature Center is they already have some established habitats that are easy access, versus if I tried to do it around school. We do have some… We're lucky. We have some good habitats out here. But the access to like a pond or water or things like that is not easy. So my first thing is, what do they have that I can use in my curriculum? It's not really, what is their program? It's more, what do they have? [Laughs.]

Christy: Right.

Kathryn: We did a lot of physical science stuff at the beginning of the year, so the Children's Museum had an exhibit on spring. So it just made sense that we go there. We will not go there every year, because it will depend on the exhibit. I don't just say, "Okay. We're going to schedule every single year the Children's Museum." I've got to look at the schedule and see what's there. It's got to tie into my curriculum. The majority of the time, I try to use whatever facility we go to as a culminating end of the unit type of activity. I usually don't have it to introduce, because I want the kids to have enough background knowledge that whatever they see or do there, it has some conceptual framework to plug into.

Christy: Right.

Appendix D.1 *(continued)*

Kathryn: That it's not our first time. My reasoning behind that of not being a first time is the first thing that happens when you leave campus is they get a little bit distracted. So if you're having it as first time learning, I think that's real difficult for a lot of kids, because they are more looking out. If they've already been engaged in the concept in some way, then everything they hear is plugging back into that concept, instead of kind of hitting a blank wall and bouncing off and ricocheting somewhere else where you don't want it to be. [Laughs.]

Christy: Sure. [Laughs.] That's right.

Kathryn: So you know, the Nature Center, I'm able to use at many, many different levels, because they have a huge variety of programs and they have a huge facility actually. We do a pond unit, which is a required unit in first grade in our district, so it is a natural to go to their pond. Usually I let them do their program. I try to always be sure that I've been there and talked to them and looked at what their program consists of. And I'll tell them about the things I want to emphasize in it. I think that's really important to have communication. I think too often what we've done is had them just send out, "Here is your program. This is what I'm going to do," and the teacher has no input into it. So I luckily enough have worked with all of these facilities enough that I can say, "This is what I'd really like to happen."

Christy: So communication between you and [them], so that it's not just they are doing the program.

Kathryn: Right.

Christy: Right.

Kathryn: You've got to get in there and do it. It is really good if you can prepare your parents ahead of time for what we're doing.

Christy: How do you do that?

Kathryn: Just little parent meetings before or telephone calls. You know, grab them for the first few minutes and say, "This is what we're going to focus on," just so they have an idea.

Christy: Uh-huh. And you have parents come with you?

Appendix D.1 *(continued)*

Kathryn: Yes, usually one or two, depending on the trip. You know, some trips you don't need anybody. If you're going to be able to sit down and go to the theatre and see a play and it ties in with something you're doing in creative dramatics, then that would be different. You probably don't need anybody there, because they're not going to be getting up and doing a whole lot. But if it's something like going around that pond, you need extra eyes.

Christy: Sure.

Kathryn: Just so the kids can go, "Oh, did you see that turtle?" You have 20 kids. It's hard to do that, even with another docent from whatever facility you are at. The other thing about working with them is most of those facilities I do not just spend the allotted time in them that they give you, like an hour. Because we go and do the tour at the Nature Center, but then I already have planned a scavenger hunt maybe looking at the animals or we'll go on the nature trail. I actually follow up the pond trip with taking things in clear buckets and insect larvae identification keys and stuff, and after they've done the pond thing, we tromp down to the creek and see right there. [Laughs.]

Christy: Right there. So when you say you don't do just hanging out in the facilities, is that what you mean, you have another activity planned for them?

Kathryn: Yeah, usually, some kind of follow up. So a lot of our field trips are actually all day long. You plan whatever you're going to do in the morning, plan the lunch, and then plan some kind of follow-up activity to go with it.

Christy: How great. How many field trips do you usually take? Are you limited?

Kathryn: Four or five a year, and they are a real variety. We always have a fine arts of some kind. I loved working with the Art Museum, because they used to have… I don't think they do now since the facility is being renovated, but the last few years they've had like a family art display of some kind that went along a theme, like patterns, and they would collect artwork that would be the pattern. So the docents would take the kids through there, and then they had like a 'make and take' room, where the kids could actually do hands-on activities.

Christy: So they see all of this and then they kind of…

Kathryn: Yeah. And so if you knew that was going to be there, then you could study patterns right before and quilts and things like that and math and tie it into whatever you did in the art. We have a neat program here called ‘Gallery Greats’ where every month a parent docent comes and brings a print of a famous artwork and teaches about the artist and the time period in that particular work and shares some of the other works in picture books and stuff of the artist.

Christy: How wonderful!

Kathryn: And so the picture is up on those file cabinets over there for this month. And they come in and the parents talk about it. The picture stays here for a month. Then we take it back to the library and get a new one. So the kids don’t do an in depth study of Renoir, but you know, they’ve been exposed to Renoir.

Christy: They’ve had exposure.

Kathryn: Yeah. So that’s really neat. The Children’s Museum had the exhibit on… It wasn’t Daegauh[sp?]. I don’t even remember. But in the fall. That’s one of the reasons we scheduled because our Gallery Great was that particular artist.

Christy: How perfect.

Kathryn: So it was neat to go in and do that kind of stuff. So if you can do those kind of tie-ins, I think it’s really important. Another group that I’ve worked with extensively is Port Conner Aquarium.

Christy: Oh, yeah? How do you work with them?

Kathryn: It’s not local.

Christy: Yeah.

Kathryn: The biggest field trip I take with my kids is a weekend trip. I’ve done it for six years now. We go to the university marine science institute. We stay for two nights. Each child brings a parent. We study the beach sounds, and we study the jetty, and we do the beach cleanup. We go to the Port Conner Aquarium

Christy: What a fun trip!

Appendix D.1 *(continued*

Kathryn: It’s a family trip. Last year we had 80 go on it.

Christy: When you take these trips, is it usually, you know, like the first grade or is there sometimes you take just your class.

Kathryn: No. This is just multi-age. I did it when I taught kindergarten too. Because it’s on a weekend, it’s not a school field trip. You know, the parents have to provide their own transportation and stuff like that. But it’s one that I’ve worked pretty extensively with Port Conner Aquarium [on], so that we knew what was going on and I knew what exhibits were there ahead of time, so I could have my kids prepared. This last time it was seahorses, so we needed to study seahorses before we ever went in there. But the Institute is real good. I’ve worked with them. They will stock the tanks and the pier lab, so I can go in and they will give me the key, and I can set out trays and put crabs in them and stuff like that, so the kids can just touch them and look at them.

Christy: So you go in beforehand and try to set things up the way you want it to work.

Kathryn: Generally, now I’ve done it so much, I just call the university and say, “I need these guys in this tank,” and they set them up for me. Yeah.

Christy: That’s wonderful.

Kathryn: Yeah. And then I just get the key, and the morning of [our visit], I go in and set it up. Sometimes when they don’t have much, then I will use the tanks they have on exhibit in the Visitor Center. Behind the scenes there, there are some tanks that I can pull stuff out of, and I’ll do that.

Appendix D.2
Observation Notes Sample

Friday, February 16, 2001
Greg
Observation at Nature Center

Greg's students were scheduled from 12 to 2 at the NC. I waited with Lisa and the director for them. The kids literally came running up because they were late. They were excited and one of them carried their pond survey kit. They all had on their GYS shirts. They took a picture together so that the director could show it off at his presentation to AAAS – they are one of 12 museum-teacher partnerships throughout the U.S. partially funded by AAAS.

We all then went back to a classroom and Greg began to review some of the pond invertebrates they had been learning. He seemed to take charge immediately and Lisa and another staff member readied their pond kits while he talked. Their plan is to have models of these animals at the Science Fun Day, so they need to be familiar with the animals. Lisa showed them some examples of models of dragonflies to note the detail they would have to know. The plane (from what I could tell) was to continue their pond survey. They split into groups and were assigned particular spots along the pond – of which they were familiar. They had tubs, nets, petri dishes, cups, magnifying glasses and a sheet to record what invertebrates they found, and some other characteristics of the pond water – which apparently they have a fancy device that measures temperature and all sorts of things, but they didn't have it that day.

I rotated between several groups as they looked for organisms. They collected leaf bags, and then sorted through it. Most of them were very meticulous and sorted animals into different containers depending on what type. They knew what some of them were – like blood worms, leaches, snails, snail eggs, but had trouble distinguishing between mayflies and damselfly larvae. They are just learning all of this. Greg would come by with a guide book and help them identify what they had. Most of them were self-starters and seemed to work well as a team. Others were more easily distracted or weren't as organized but they were all interested in the organisms, and even wanted to search elsewhere for more. Lisa and an assistant also helped the groups. I would ask the students about what they had, and they were eager to share with me.

Appendix D.2 *(continued)*

I was never formally introduced to the students, but they seemed to know what I was there for – so Greg must have told them. They were fine with me hanging around them. Greg said they would be at the Science Fun Day and that I was welcome to come. I said I would. He said they wouldn't be back at the NC until mid-March.. Overall, I was impressed with the group and how they worked with the staff at the NC. It was obvious that teachers are well-respected there, especially ones like Greg. I got the sense of a true partnership there – they worked more like a team – not like they were participating in a program run by the NC. That is what made it more exciting – it was THEIR project – and that was clear.

Appendix D.3

Sample Document: Vicki's Application for Teacher of the Year

2001 TEACHER OF THE YEAR INFORMATION SHEET

Name	[redacted]
School	[redacted] Elementary
Grade/Subject	3rd grade
Principal	[redacted]
School Phone #	[redacted]
School Fax #	
Classroom Phone # or Voice Mail #	[redacted]
My school is in area	2
Number of Years of Teaching	16
Number of Years Teaching in	16
Home Phone #	[redacted]
Social Security #	[redacted]

Professional Biography

I did not actively participate in my elementary school experience. School was a place that I went to for 8 hours a day and interacted with my friends. I frequently sought the "easy way out" when completing assignments and did not fully apply myself to my studies. As I got into the upper grades, I realized just how little I could do and still make a passing grade. Teachers, for the most part, accepted my mediocre work. They easily overlooked me and did not challenge me as a result of my quiet, passive demeanor. I took complete advantage of the situation and did not offer more than what was asked of me. I loved reading and read during recess and class time. I would hide my books under my desk and read while the teacher talked.

I expected junior high to be more of what I had experienced in elementary school. I anticipated long boring days waiting for the last school bell to ring so that I could go home and be free to read my books. I had to sign up for Texas history and prepared myself for a long year of boring dates and trivial facts about people long since dead. Their existence held little relevance on my current situation. The first day of class proved me wrong. In walked a short, red headed teacher who had a quick wit and outgoing personality. He made history come alive. He got everyone involved in projects, skits, and reenactments of famous events. We read first hand historical accounts and novels which helped us understand the people of the times we studied. He did not allow passive listening in his class. I could no longer hide books under my desk and tune out. Everyone in class had a job to complete be it script writer, editor, set designer or information gatherer. Each lesson related to the one before it leading us on a wonderful adventure through time.

I began to view school through new eyes. A spark had been embedded into my subconscious; the desire to teach. This spark smoldered as I went through high school and applied to college. In my preregistration packet I received a choice sheet which asked me to declare a major. I slowly read over the paper and wondered, "What do I want to study for the next four years? What career could I enthusiastically pursue for 10, 20 or 30 years?"

The smoldering spark, that I had carried within me since junior high ignited into a burning fire. I knew that I wanted to be a teacher and that I could make the difference in the life of child. I proudly signed up to be an education major.

The past 16 years have been filled with challenges, accomplishments and successes that proved to me that I had chosen the best profession for my talents. I have organized science fairs at the campus level for the past 5 years. I also developed an after school Invention Club which won awards for creativity and invention design. I coached a group of third graders who won 1st and 2nd place awards a their first Math Pentathlon competition. I have been very proud of these accomplishments. I received great satisfaction upon seeing my students' faces as they received awards for their hard work. All of these accomplishments reflected well on me as their teacher.

However, I'm the most proud of the fact that after 16 years in education, I still walk into my classroom with the love of teaching still inside of me. I possess a sense of pride in the fact that I have made my classroom a place of active learning. I offer my students many hands-on opportunities that allow them to discover and explore many concepts. My proudest moments are when students ask permission to stay after school to read with me or work on a project. It is at these times that I know I have made a difference in the lives of the children I teach. This gives me great satisfaction in being a teacher. These small day to day victories are the true measures of my job and encourage me to do the best that I can do.

Philosophy of Teaching

Each child needs to feel a sense of self worth and accomplishment in their daily lives. When a child comes into my classroom, it is important for me to demonstrate that he/she is a welcomed and honored member of our small community. Schools should be a safe and inviting place where each child wants to spend the majority of his/her day. Once a child develops a strong sense of belonging he/she will want to attend class regularly and become an active learner. Getting the child to want to come to class is half the battle.

I have implemented Tribes philosophy and techniques in my classroom. This process teaches children that they are an integral part of the school and that their opinions and ideas are valued. By sharing in a community circle, the children are encouraged to express how they feel about school. They recognize their role in developing a sense of community in the classroom. I encourage my students to discuss personal issues in a safe and caring environment.

I try to create a student centered classroom. I encourage children to explore and learn more about the topics we study. They give suggestions as to what they would like to read more about and they are allowed to go to the library to research. I try to foster independence in my students by listening to what they feel is important to them in their studies. I also supply them with hands-on

Appendix D.3 *(continued)*

experiences that make learning an engaging experience. Students select roles and I give them clear expectations that help to facilitate their learning.

As a teacher, it is important for me to give my students the necessary strengths and skills in order for them to become independent and life long learners. What better way to accomplish this than to start with a strong sense of self-confidence and personal worth.

Appendix D.4
Sample Document: Vicki's Museum Camp Curriculum

Day 2: Urban Nature Search

Objective
Students will be able to generalize that each environment has characteristic life forms.

Materials
Questionnaires
Notebooks or journals
Pencils
An outdoor setting to conduct the investigation

Activity
1. Preview and select the route of the nature search. Note stopping places where students can observe and record information.
2. Design a questionnaire to be distributed to the students for use on the "search". The questions and tasks should encourage increased student observation. For example, many of the following phenomena can be designed into this activity:
   a. Tally, describe and sketch different kinds of plants growing on the north and south sides of buildings. (The differences may be due to temperature variations, sun and shade-loving species of plant, and less evaporation on the north side of the building.)
   b. Look for birds. Tally the numbers of different kinds of birds. If they are migratory, sketch the pattern of their flying formation.

Discussion
Every environment has its characteristic life forms – including animals – and the urban setting is no exception. Many of these life forms have adjusted as their habitat has changed from undeveloped to urban. Not only have people altered the environment, the human environment has been shaped by the characteristics of the ecologies within which people live.

Appendix D.4 *(continued)*

The major purpose of this activity is for students to recognize that all environments have characteristic life forms.

It's a Small World

Some small things I saw.	Draw your favorite thing.
Tell about a sound you noticed.	Draw something that moved.
Describe something your touched. Tell how it felt.	What surprised you?
What did you collect in your bag?	Draw one item you collected.

Appendix E.1
Coded Interview: Suzanne Interview 2 (actual names removed)

Interview #2
June 28, 2001
Phone interview

CHRISTY: Okay… you told me a little bit about your PALS curriculum. But could you tell me more about this and why you decided to create it?

Talk about directly related to study trips – or at least the kind of study trips I like to take best. The study trips and PALS sort of evolved hand-in-hand because PALS is based on a need for children to learn to read in a setting, or within a context that they are really, really excited about. And there's nothing more exciting to a child than science – especially biological sciences. They love the physical sciences and earth science but they love biology.

Curriculum Writing~
GOOD QUOTE
Using ISE - reasons/

Love of Science
Teaching constraint

CHRISTY: So all of them are based on plants or animals?

Well…most of them. The PALS are all environmentally based in some way and that's what is so cool about them. The kids just love them. And we have other reading programs. I interface it with Saxon which is highly phonetic – so they get the excitement about the letter – it's based on a letter a week. They get their excitement about the letter from the PALS and their science related to the letter from the PALS and the Saxon kind of fills in on the phonics. They also get fine motor. They're coming out now – I have three of the books.

Curriculum Writing~

CHRISTY: Yea. How does it look?

It's pretty nice. The cover is pretty nice.

CHRISTY: Well, congratulations!

I know. There are literacy connections, writing connections, mathematics, science, social studies, fine arts. I had forgotten all of this. Physical education and assessment connections. It's a full range deal. But it is truly very related to study trips – in my situation. I think the only study trip that I go on that's not directly related to a PAL – even the farm is related because our G PAL is Gary the Global Gardener. And we talk about – actually now she's Golda – we had to get ethnic minority female. We talk about world hunger, desertification and overgrazing.

Curriculum Writing~

Curriculum Writing~
Using ISE - reasons/

CHRISTY: Wow. Such big ideas for kindergartners!

Appendix E.1 *(continued)*

It's amazing though Christy – they can handle anything you give them.

Thoughts on teachin

CHRISTY: So what made you decide to create this curriculum?

Curriculum Writing~

Well – and I were using the Letter People – Alphatime Phonic Program.
CHRISTY: You and who?

– my writing partner – long time friend. Teaching partner for five years at Elementary and then I moved out here and she stayed at but we wrote this curriculum together. And the Letter People is like a 60's based stupid phonics deal so we decided to sub out the letter people with more exciting, environmentally based characters of the week. That's how we came up with all these guys. But even the farm, we go to the Farm, is based on farming and they do Texas some – Texas native animals. We decided to do it because we were tired of doing Munching Mouse – dumb stuff. Stupid stuff. We started subbing out our own guys. We tried to stay in a back yard format, because young children learn best with what they can touch, see, feel, hear. You know. So we chose Deborah the dandelion as a plant, and we chose Max the xeriscape yucca for our X PAL – prickly leaf yucca. It's wonderful stuff. Just wonderful connections with their lives. It's really cool.

Curriculum Writing~

Curriculum Writing·

Thoughts on teachin

CHRISTY: So that really is the basis of your curriculum?

It's the basis of my curriculum. I hope it becomes – at least the science basis for a lot of other people. We'll see. Yes. It's the basis of my curriculum and it's the basis of Carol's curriculum, but we teach it more intensely than anybody else. But the people that we're around that we teach with have gradually taken it because Kindergarten still remains a grade level without science for teachers. So the teachers in my school took the science. Christy, I scripted it. I wrote lesson plans that they can read and they can get a student response and then listen to the student response that's on the script – because I've done it so long, I know exactly what they're going to say. So they like it. They like the fact that its brain based and backyardy. I mean A is Air. Think of all the incredible experiments that we do with air. Just wonderful. V is Victor the Volcano.

Curriculum Writing~

Teaching Science

Curriculum Writin

CHRISTY: That is so impressive – just the fact that you bring all of that science to your kids.

CHRISTY: Are you unique in that regard? Do other teachers normally bring that much science to their kids?

Love of Science
Science leader~

Curriculum Writing~
Teaching Science

. No. I have a reputation as the science teacher. In fact, if somebody wants to request me they just write SCIENCE in capital letters. But people are becoming – because PALS is so user friendly, there was more science taught in the Bee Cave kindergarten than I've ever seen taught in any other kindergarten at any other time. And Carol feels the same way about Odem now. So..it is just a matter of placing science in teachers hands in a way that they really can use it. You know its just so hard to gather all those materials and look in books and find experiments, and tie it all together. It's tough for teachers. It's their weakest link across the board. You know that. And when you do it when it's tied in to reading then that doesn't make it a discontinuance from the rest of the day. And to be truthful, when its our phonics time, we just end up usually going off track completely and doing science. We do phonics and my kids leave being excellent readers, but we do a lot of science – a lot of thematic warming in. Science is great for that. The kids connect and they are so excited about words they can read like "metamorphosis" and "echinoderm". I was just teaching echinoderm to my low readers today. It fires them up that they can get information about what they really really want to know about by reading. And it's a real powerful tool for them and they make that connection really quickly because the content is very heart felt. I mean I can't sit down on the playground without having some kids sticking an isopod or a terrestrial univalve in my face! (both laughing) Sometimes I just want to say, "Go play!" (both laughing)

Curriculum Writing~
Teaching Science
Thoughts on teaching/l

Love of Science
Teaching Science
Thoughts on teaching/

Teaching Science

CHRISTY: Isn't that great!

Teaching Science

It is great. It is great. And it just unfolded and we had more fun just unfolding it. It was a lot of hard work for a long time but it's really cool. And every study trip that we go on, the kids look out the window and say, "Max! Deborah! Randy! Arial!" The look up and look at the clouds and they know, cirrus, stratus, nimbus and cumulous. Carol is really good at writing piggy back songs to go with all this stuff. And children learn so much through songs. And if you sing a song everyday, pretty soon they'll look and say, "Look at the cumulous cloud" It's just real connective to their real world and we hope – our ardent hope is that it teaches children to be better care-takers of the planet. That's my most ardent hope. And I see that as my role in working with young children – is to build people who have a little bit of awareness about what is going

Curriculum Writing~
Thoughts on teaching/

Curriculum Writing~
Thoughts on teaching/l

on. I mean, I was at three days ago taking my recycling and the guy came out of the door and said, "We're not taking any more colored plastic." And I said, "But you're taking the clear plastic. Well, I've got some Pete's here that are colored." And he said, "Well, my name is Pete." He had no clue what I was talking about. He had no clue that plastics are graded. At – as an employee. That's bad. You know that's the shape we're in because that's the standard mode with people. I drive the parents crazy because they can't mow they're dandelions, they have to eat them. (both laughing) They have to recycle. They have to compost. And kids are relentless. (both laughing) I tell the kids, "You're mom and dad are not going to want to do this and they're going to forget and you're going to find aluminum cans in the trash! And you don't have to be mad at them, just get the cans out and remind them." And the parents are like, "Would you stop it now with this stuff!"

Love of Science
Thoughts on teachi

CHRISTY: Have you always based what you teach around science?

.I always have.

CHRISTY: Why is that?

I was raised with a biologist. My dad was a research mammalogist.

Background- Growin
Family's love of scier

CHRISTY: I didn't know that! A mammalogist?

Mostly. He was a deer guy. He did a lot of the basic research on deer that people take for granted now. He was Mr. Deer of Texas – . He went to Africa to do research on wildebeest and that's how I got over there and that's how I got over there and that's how I got interested in that whole part of the world.

Background- Growi

CHRISTY: So tell me about that. You haven't told me a thing.

Well – I traveled and then I went and spent a month with them while they were living on the Serengeti.

Family's love of scier
Love of Science

CHRISTY: Your parents?

Uh huh. Just loved it so much. I decided that's where I was going to go back to. So I got my degree and I was going to go back and teach in an international school in (inaudible). But I quickly – then I married in the interim to this asshole that I'm dealing with

Background - jobs

now. (both laughing) I don't know where my head was! We got over there and realized that the Serengeti was not in Dar Salam (?). They are two entirely different places. So we started our own photographic safari company.

CHRISTY: You and your husband?

. Yea. So I had to spend another three years running safaris. So I built up my knowledge at that time.

Background - jobs b

CHRISTY: No kidding. You are a wealth of knowledge!

Well....not really. I know a little bit about a lot of stuff. If I had it to do over again I would probably go into the biological sciences as a profession. And there are very few teachers that have any interest in science. Most of them go, "Ooh! Yuck! A bug!" And so I am unusual in that sense. But, I'm hoping that making science friendly with PALS will help that whole process – help teachers become more comfortable and teach it a little more. I don't know. We'll see.

Love of Science

Teaching Science
Thoughts on Teacl

Curriculum Writing

CHRISTY: How did get involved with it?

Well – he was, at first. When I first started writing it, I called him because I had had him for a course and asked him to recommend some publishers. And he did. And I sent them to the publishers – sent the original stuff. It was really raw and basic – to a couple of publishers and it was rejected. So that's basically that's all that he....

Curriculum Writing~

CHRISTY: And then you started refining it?

. Yea. We wrote it over a 6 year period. And then here in town bought it. The books are about 600 pages each and there are 26 of them. One for each letter of the alphabet.

Curriculum Writing~

CHRISTY: Wow. What an accomplishment.

(laughing) And the social studies is cool too because there is tons of social studies that just naturally goes with science. We do every habitat on the planet – through some PAL or another. It's just wonderful social studies stuff. Cool stuff. All those lessons are directly related to the science of the week. We're doing Carlos the Cautious Cactus and the social studies is connected to living in the desert, farming in the desert, products from the desert, people of the desert. You know.

Curriculum Writing~
Teaching Science

CHRISTY: So kindergarten has curriculum for what then?

Language arts and math and that's it. Now there are interrelated curriculums like PALS. They're very thematic. They do fine motor. They do music. McGraw Hill is the one that our school district adopted. But they don't do science. They try. They try. They'll do a little do-da here and a little do-da there but it's not really anything. And I to this day use Barufaldi's wonderful book that he wrote a long time ago with the marbles on the front. I can't remember what the name of it is but I love it. So that's my connection with him. Other that the fact that I just love him. He is just the most....

CHRISTY: So you took some courses?

. I took one course with him and I just loved it! I just loved it.

CHRISTY: What was this for?

. That was during – I believe it was in my masters degree. It was science ed.

CHRISTY: So you have a master in science ed?

: I have a masters in C & I - curriculum and instruction. Teacher Corp was around. You know you're a lot younger than I am but in the seventies there was still this big push left over from the sixties to get out there and help everybody in the world. So sort of in conjunction with the Peace Corp, the government funded Teacher Corp.. They took teachers and trained them even more while we taught and paid for our educations and then we agreed to teach in low income areas for a certain number of years. It was really neat.

CHRISTY: Oh, I see. So you got your masters degree and then you taught...

. While I was teaching. It was tough. We were almost doing full-time, I was doing three courses. I did a non-thesis degree and I took 36 hours in two years.

CHRISTY: Wow. That's a lot – especially when you're working full time.

. Yea. And I was young and idealistic and lived for school. You know the drill. Maybe you don't know the drill. It's a drill. I

Thoughts on teachin

Background - grad
Inspirations~

Background - grad s

Background - grad s

Background - grad s

Background - Teachi
Thoughts on Teachir

it so much in young teachers anymore.

CHRISTY: How's that?

That sort of driven – "I'm going to help the universe." "I'm going to be a social worker and a teacher." I've been in the classroom for 23 years. We went to homes. We helped provide food. We did nurturing for the families in ways that educators just don't do anymore. Interesting.

"Missionary work"
Above and Beyond~
Background - Teaching

CHRISTY: Has that changed in how you deal with kids and families now? Or is it just that you're at a different school?

Well – a different kind of family now. They'd probably be insulted. I interfere *enough with this PALS stuff – I'll tell* you.

School demographics -

CHRISTY: So you taught in some low income schools then?

Yea. For 11 years I was on the east side of Austin. Yep.

Low SES school~

CHRISTY: What made you change?

Divorce. D – I – V- O- R- C- E. I was looking for a place to live and I had a little money from the house we sold in Westlake so I built a house out here and just applied for the heck of it and got a job. The whole demeanor of this school district is different from the east side of Austin. It's really different.

Background - Teaching-
Personal illness/crisis~

School demographics

CHRISTY: How's that?

Well – income level. Everybody is richer than I am. I'm not rich, but everybody is way richer than I am – makes way more money than I do. Lots of mothers that don't work. Lots of help in the classroom. You know – affluence – makes such a difference. Kids that get all kinds of exposure to reading and other concepts. And kids who are well-traveled – who have been many times to the Children's Museum or have been to the state capitol. They are wise in the ways of the community.

CHRISTY: How has teaching at different schools with different socioeconomic levels affected your study trips or anything?

Well, I took kids to the same places. It's funny, I was already sort of intuitively teaching PALS. I mean, it's been building in the program ever since I started teaching. And the study trips I was taking at Allison in '76 are very similar to the study

School demographics -
Using ISE - reasons/thc

[illegible] now. We did more ethnic things on the east side, .like go to tortilla factories. But study trips have always been real important to me because the community and the place where kids live is of utmost importance and just being a knowledgeable person and having a background to build vocabulary. And having a background to build knowledge. And it started out being real important to me because those kids on the east side almost never went anywhere. And it was almost essential that they be taken out into the community. Now – it's kind of a luxury. But it's cool because now I don't have to do so much work with "Well, this is downtown." You know what I mean. "This is a city." As opposed to, "Here is the River. We call it Lake." My focus has kind of changed from basic stuff to content within the study trip. It's more related to what we're studying. Does that make sense?

GOOD QUOTE
Using ISE - reasons/th

Low SES school~

School demographics

CHRISTY: Yea. You're not just focused on where you are. That novel idea of just going somewhere. So you also mentioned before about the community being so important for children.

Yea. How can we feel any community with our planet if we can't feel any community with our community. You know what I mean? You feel community with your home, then you feel community with your neighborhood, and then you feel community with your city. And until a child feels a sense of belonging or connection, then there is no urgency to interact, to protect. Be in. Do for. All those things we try to teach kids to do. Know about. I don't know. That's just my basic sense about it. Study trips, as you well know, are an endangered species because of the whole push on reading. And people don't seem to make the connection that study trips are an incredible way to teach reading.

Thoughts on teaching/l
Using ISE - reasons/th

GOOD QUOTE
Thoughts on teaching
Using ISE - reasons/t

CHRISTY: Is your principal real supportive of what you're doing?

Principal Support~

: Yes. I am so lucky. I have had principals that haven't been. My last principal was a maniacal, narcissistic, horrible person who literally thought that snakes were an instrument of the devil – could be used to do voo-doo.

Background - Teachir

CHRISTY: That's kind of ignorant.

: Duh! She was so anti-nature so you can imagine where I stood.

Principal Support~

CHRISTY: She thought you were a crazy woman.

I was crazy. And I had a ball-python and she was afraid to come into my room. It was good in some ways because she was scared to death. She thought I could put a spell on her.

CHRISTY: No! Is she still there?

She was removed from the principalship and was put into a higher position into personnel. But we just found out that she resigned. But she was removed because parents finally realized that she was an anathma to education. She would (inaudible) instead of asking questions. And thank goodness that they realized that because she was just horrible. But is just the exact opposite. She's very supportive of everything we do. I'm so proud of her. And loves nature and loves the Wildflower Center. I got her to go out there because we were doing a training. I got the teachers to all go do the training at the Wildflower Center so that we could take the backpacks. Oh- you were there!

Background - Teach
Principal Support~
Principal Support~
Wildflower Center
Science leader~

CHRISTY: Did the district pay for all of that?

Yea. The district paid. And she started going and now the Wildflower Center is her favorite place and she's doing native plants. She stands behind the concept of the natural world. She's such a rarity. I always just give her a hug and say, "Thank you, Thank you, Thank you!" Because I've been there and done that where they look at dirt as something to clean up instead of something to plant something in.

Principal Support~

CHRISTY: You said, though, that you're field trips may be reduced.

Well, I know. I'm not sure about it but there seems to be a push to reduce the study trips. I could never get a straight answer out of . And I know why. They're a lot trouble to do. And teachers don't like to do them. And you know this because they're a lot of trouble. I mean, people....they're a lot of trouble.

Field Trip /Project C

(interrupted briefly by another call)

CHRISTY: You were talking about what a pain it is to schedule and do all these field trips and teachers don't do it.

And so they don't do it. So if you have. So the benchmark then for field trips comes down to the lowest level. In other words, I can't do study trips if I can't get everybody to do them with me.

Dragging people alor
Field Trip /Project C

CHRISTY: Therefore nobody will go.

'. Therefore study trips....if there isn't somebody like me saying, "Look – I'll plan them all. I'll write the permission notes, I'll put your name on them. All you have to do is collect the permission notes and get on the bus." If there's not somebody like me doing that, then they fall by the wayside. And in all fairness, there is so much pressure now to get from point A to point B with kids that teachers feel like they just can't afford the time. But it's also a matter of energy and work. And so I just do it. Originally, when I came Lake nobody was doing study trips. And I had come from where we were really hopping around the city. So I just hired my own bus, had my kids pay their $5. I told you this, I think. Had the kids pay their #5 for the bus. Had them even pay their entry fee, and they could do it out here. And my class would merrily drive off into the sunset. Well, the other teachers started looking at my program and saying, "Well – we want to do too." Then it got kind of sticky because here I was going all of these places and if you were a parent, wouldn't you want your kid to be in that class so your kid could go to those places.

Making Field Trips H

Field Trip /Project
Thoughts on Teach

Making Field Trips H

CHRISTY: So the other teachers were feeling pressured?

. They were feeling pressured. So I said. "Okay, instead of giving them up, let me take you into my fold. And we'll all go to all these places." Everybody went, "Yeah!" Kindergarten teachers are wonderful anyway. Kindergarten teachers are renowned for doing kinesthetic...

Making Field Trips H

CHRISTY: They all want these experiences for the kids.

.: Right. We are a different breed of cats, I must say.

CHRISTY: From even first grade?

Yea. Oh, way yea. So that's how all the study trips in Lake Travis evolved and then....we were one school then. So I was planning our trips for – when we were at our largest – every trip for 10 classrooms. 10 to 12 classrooms. I did all the scheduling, all the booking. It's hard to book these things for 10 different classrooms.

CHRISTY: Don't you have to do them on separate days?

. Yea. Yea. And now just this year, got so big that I started having to do 2 day jaunts. Up until last year, I could get us all in on one day because there were only four of us but then we went up to six in one year. And you just can't do 6 classes in one day at a lot of these places. You know – the

Making Field Trips H

Museum – these places will only take at most, 60 kids a day. So anyway – I have just done study trips for the kindergarten for the district – well, not for . An good friend of mine who is also a science person went to and she – they basically do the same things we do. And now we have 3 elementary schools, and there is another good friend who is basically doing the same thing at at the old school. kindergarten program in fairly uniform. But is so big, there are variations in the kindergarten involvement in study trips there as I'm sure you've found out.

District issues/supp

CHRISTY: I don't really know on the kindergarten level, though. You're my only kindergarten teacher.

Well, is.... There are schools that travel all the time, and there are schools that don't travel much at all. The same people see me every year (at informal institutions). The only place that I have to really worm my way in is the Art Museum. Every year I have to. I finally got the same person booking for the last three years, so she is okay. But I still have to tip toe around her and assure her that our kindergarteners are very capable of enjoying the paintings without ....

District issues/supp
Using ISE - reasons
Other field trips~

CHRISTY: Because they don't normally take kindergarteners?

: They don't. But every time we leave, boy howdy, do those guards compliment us. I take all the kindergartners at once and we do a lot of talking about museums, what museums are for, how we museums, we talk about different kinds of museums. They go in with a really good attitude about being in a museum. And the teachers are good. The teachers take on the responsibility of ....take the attitude that this is a special place for special kinds of learning. The kids love the Art Museum .They love those huge paintings. They just think they're wonderful. And the sculptures – and these wonderful strange – the blue lady in the old metal chair. You can just see their little minds clicking. And they've all had easels in the room, so they all are painterly in that sense. They all have had experience with paint. It is one of my favorite places to take kids.

Pre and Post Field
Using ISE - reasons

CHRISTY: So what do combine that trip with?

. I combine that one with the Museum. We get dropped off at the and we do the and then we walk across campus and interview students about going to the university. We talk about the university. And the university kids are just wonderful. They just love to talk about what they're doing

Field Trip Structure

and finally I have to say, "Okay, we're going to go on now." And then we eat lunch in front of the music building and across the street from the Museum and then we go in. For three years, while I was doing them by myself, I found a wonderful geology professor, and we stopped in the geology building on our walk and got a lecture on rocks, just like university kids would. And then we rushed on to the museum. But we can't do that with so many classes.

CHRISTY: This is also when you tried to schedule the butterfly lady?

Field Trip Structure~

Right. And last year we went up and saw the solar – the sun telescope. It was really hard to try and get everything in that one time. It's really tough. It's a lot. They're tired but they change modalities enough so that they were okay. They were much less tired than they were on the trip that you were on at the Wildflower Center. They were bushed that day. They were so tired. Did you go the zoo too?

CHRISTY: No. But I know ya'll went in the morning.

Thoughts on teachinɛ

. They were tired. I've never seen a group of kids so tired. But that group of kids was a really thinkerly group. They were so tired from thinking so much. They would say, when we'd be talking about science, before they would answer, "I'm going to take a risk." I always say, "Take a risk. It doesn't matter if its right or wrong. Take a risk." They were an amazing group of kids and it was interesting because they were just worn out from taking risks. (both laughing)

CHRISTY: Well you're kids are so bright!

Pre and Post Field Ti
Using ISE · reasons/

Thoughts on teachir

Well, I was hard on them. I'm sorry. I was kind of grouchy at the end because I was tired too and I thought, "Christy must think I'm an ogre." We got back and processed. And the next day, there is just a plethora of stuff going on. They right, they draw. They do experience charts. We connect the classroom to what we saw. And you know they were tiring to me because people like Johnathon, you were standing there when he read the scientific name. That is hard to have people like who are at like a third grade level, and my little guy at a four year old level. It's hard to keep everyone on task, and interested. And giving everyone something to think about on their own development level.

CHRISTY: Yea. You're tired.

I was bushed. It was wonderful.

CHRISTY: That's hard work. I can't believe you take all those trips.

Well, it's hard work. I looked around at my team mates – because I was team leader too –and said, "Is there anyone that wants to take my study trip job?" And there was a dead silence. Come on guys! Give me a break here.

Making Field Trips H Science leader~

CHRISTY: Now in the first grade, second grade – they only do one or two a year?

They do two. I think first grade just did one last year.

Field Trip Structure

CHRISTY: So do you think there's pressure from those parents whose kids have gone on all these trips?

Yea. They come back to me and say, "Golly. This is not the same." The kids come back and say, "We haven't gone on any trips!" Yea. There's pressure.

ISE: Parent Issues/S

CHRISTY: So, like you said, it could come down to "Well, this is getting too much."

That's right. And the first grade can squeeze us in ways that is just amazing. And so the popular opinion among the first grade teachers is...well, among the ones who are more oriented around children, they're real excited about it. And their justification about it, and rightly so, is that they have so many things they have to...They have such a high level that they have to get those kids to for 2nd grade. And its' becoming more and more that way for us, so there's more pressure from my peers, my kindergarten peers, to make these trips as literary as possible You know, to really relate the reading and writing to it. But, I don't know. It's easy to do.

Field Trip /Project C

CHRISTY: Easy to do what?

Easy to relate the literary – the reading experience – to the trip.

CHRISTY: You've already been doing it.

Yea.

CHRISTY: So tell me more about growing up loving science and your interest in biology and Africa. That is like my dream!

. (laughing) Well, you'd better hurry up and go. It's scary how it's changing. It was really fun. I didn't know that life could be anything but going out to look for turkeys with my dad. He did a lot of turkey work in north Texas – the Canadian River. When I was little, he worked for Fish and Game for a long time before he went to

Background- Growing
Love of Science

CHRISTY: So did he have a PhD?

. Yea. He was a wildlife management person. He was a professor in the wildlife management department – fish and wildlife. It was a little bitty department. Now, it's big. But it was little bitty then and he was always off in the field. I more than my brothers and sisters was interested in that and spent time doing it with him. You know it was just what he read. He never read anything but science. And I'm, to this day, the same. "Well, what are you reading?" I just go, "You don't want to know." Field Guide to the Trees and Shrubs of Texas is what I'm reading now. I found pleasure in it. I guess its early childhood based. I don't know.

Background- Growing
Love of Science

CHRISTY: And you're mom? Was she always interested in science too?

Background- Growing

. No. She could have cared less. She was just trying to survive with 5 kids. She taught kindergarten in a private setting so she was at half-day kindergarten. She was not at all interested in science. In fact, to this day, is horrified of snakes. Not in the way that Archer was (principal at last school), but just....Her comment twice in Scotland was, "Well, there aren't any snakes here." I was like, "Okay, mom." (both laughing) "There's one poisonous snake in England." She said. "That must be it." We looked at the incredible bird collection in (inaudible) Palace in Scotland, She was just focused on that snake. I don't know. I don't know. It was my dad. It was my dad that did it.

Love of Science

CHRISTY: And so when you went to college, did you know you wanted to teach?

: No. I actually went to New York to do fashion design. I left and flew away on an airplane and said, "See you guys sometime in 20 years." (laughing) But I couldn't stand New York. Living in New York City was like living in a prison for me.

Background - jobs b

CHRISTY: Different from ' ta , huh?

Background-College

I ended up coming back to Texas via California and just going to school. I didn't know what I wanted to do. And ended up in education. I was one the first education majors to go through was about the only teacher there in education. She was from there's a elementary school. That's her. She was wonderful. She was my mentor and guide. Really, really good. I just took an education course for the fun of it and it happened to be hers and she really guided me into the teaching profession. She really did push. She was a good friend.

Inspirations~

CHRISTY: Lucky she did. Everyone got a good teacher.

Thoughts on Teachir

And I got a profession that I'm dead broke in. I don't know how lucky it is, Christy. I don't recommend to any young person to go into education. When I hear they're in education, I just kind of groan.

CHRISTY: Why is that?

It's sick. It's a horrible system. I don't see it changing.

CHRISTY: When you say system, what do you mean?

Just a system of compensation. Financial compensation – of wages per hour of work breaks down to not very much – especially in your first years of teaching. I don't know. I love it a whole lot or I would think about getting out of it. I'm close to retirement. Well, 6 years. 8 years really because I sold 11 years for my asshole ex-husband.

Love of Teaching: "I

CHRISTY: You did what?

I sold my 11 years of retirement.

CHRISTY: How do you do that?

Well, you cash in. I cashed in to help invest in his business. That derailed in the divorce and I didn't get the money back.

CHRISTY: I bet that's real hard for you.

Yea, It's hard. There's a lot of bitterness. That's 11 years of my life.

Appendix E.1 *(continued)*

(We digress and talk about marital issues – not related to research topic. She did say that she is having to work through all of July now and she has never had to work through the summer before and that teaching is not a profession designed for a one-income family. We then talk about my background and she says I can start a children's museum in

summer/part-time w
Thoughts on Teachin

We need a good science discovery museum in this town. I mean, Children's Museum is wonderful but it's not a science discovery place. And we do not have one since wonderful stopped Didn't they do

Children's Museum~

CHRISTY: Now that was run by the wasn't it?

Well, not originally. I think originally it was run by – now let me remember his name – we had their child – and had What is his name? Old timers disease! The big physics teacher at . He would take physics experiments that are wonderful around – introduce children to physics with this He was really neat. He would do things like bring he got me in trouble several times during the year. He brought a deer placenta that he had – he shot the deer and he brought the placenta – when he was cleaning the deer. You know, field dressing it and he saved the placenta. He brought it to school. And Becky said, "Oh my gosh! There's a deer placenta!" He wants us to enjoy it. And I said, "Well, give it to me. We'll dissect it." So we dissected the deer placenta. And I only had one parent that – and when I was in the middle of doing it, I thought, "Oh my gosh. Am I gonna get in trouble for this!" There are going to be so many parents calling the school. But only one did. I was real proud of the community. People came to me from both – because I did it with my class and class. People came to me and talked to me about it but they said – excuse me, I'm cleaning my hummingbird feeder. The hummingbirds are swooping down at me, fussing at me. When its empty, they get in my face! It's incredible. – um, Parents would come to me – parents from other classes that didn't even see it. "Oh, You're the person – we heard about the deer placenta! I was kind of shocked at first. But now my child knows so much about placentas and babies and embryos. And when they talked about it, I was just blown away." So I got a lot of positive feed back and only one negative. Anyway, they had and they stopped it. I'm pretty sure. And I think then the Children's Museum took it over from them – when they were in the old Greyhound Bus building. And then for some reason, it just stopped happening. But somebody needs to do a in

Level of Parental In

Children's Museum~

Appendix E.1 *(continued)*

this town again. There is no place quite like that. There's plenty of life science stuff around, but there's no physical science. The weather station at the Children's Museum is really cool.

CHRISTY: So do you take your kids there?

Yea. We do the Children's Museum and the capital in one trip. We do the river, the bat bridge because our B pal is Babs the short nosed bat. Which is directly connected to Carlos the Cautious Cactus because she is the pollinator. And then Quincy the quail stays in that habitat too. We keep going back to the same habitats again and again with different pals. We do Randy the River because of the Colorado and we do the bat bridge, we do the Children's Museum and . We study Texas as a social studies unit so the capital is really a good place to go. And the fourth grade teachers go there too and they're kind of mad at me. They have always come to me because they know I'm the instigator and I just defend it to the "T" and I've got defending it too. My personal opinion about study trips is that a kid could go to the same place every year.

Field Trip Structure~

Field Trip /Project (
Using ISE - reasons

CHRISTY: So they're upset because you've already taken them there?

Yea. If you know anything about the developmental mind of a child! It's like, duh! It really burns me up.

CHRISTY: It's kind of a silly argument.

: But it's a consistent argument. It's hard. I hear it all the time. "We can't go there because you went there." I'm like, "No. The brain of a kindergartner is much different than a brain of a fourth grader. You've got different things to look at. You can do ten times the things we can do." It's almost so stupid because you can't argue about it. So, I get that a lot with study trips. Even in first grade, "Well, you take them everywhere and there is no where for use to take them." That is the argument I hear. I just get furious. They don't say it to me anymore. Because I finally just turned around and went, "Rroow (cat sound) Don't even talk to me about that!" You know, because its so dumb. It's a dumb way to look at it.

Field Trip /Project C
Thoughts on teachin
Using ISE - reasons/

CHRISTY: It's not an argument.

Well, they sure think it is.

CHRISTY: So, you were talking about the Children's Museum.

Children's Museum~

Tell me what ya'll do when you're there.

Well, we do .... I really work mine. We go up and do the whole Texas thing on the second floor. You know, there are pictures of Sam Houston, Stephen F. Austin. And I tell my kids a lot of Texas history so they know who Houston is, who Santa Ana is, who Stephen F. Austin is and we go up there and I just wear, I just bore them to death making them look at those pictures and then I just let them loose to explore. They love the little restaurant, they love the bats thing where they hang upside down, and the doctor's office. I make them go through the weather thing with me because they wouldn't understand the significance of all those specifics if they did it on their own. I loved the monarch exhibit and I liked the tree exhibit. They had some really nice, some really good combos

CHRISTY: I never saw the Monarch one.

It was good. They did a good job with it. The tree one was good too. It was real good. But the shoe one...She shoe one was good. It was fun to try on different shoes. It was real social studies oriented. It wasn't real science oriented. And I haven't taken my kids to the Natural Science Center in years. Just because we go the Zoo and because the Natural Science Center program I can do in my classroom because I have all those animals. But that trip is good one. They kids really like that one and they love the capital. They love the capital! We look at the statues of Austin and Houston and talk about the stuff they're made of – metamorphic rock. You know – they can name all of the 6 flags and the countries that they represent. Not in the right order – but they understand the concept.

Children's Museum~
Animal House~
Using ISE - reasons
Other field trips~

CHRISTY: That is so great that you expect so much of those kids.

And they can learn the vocabulary. There's no reason they can't if its taught in the right way. It's fun and exciting. And I tell you, a lot of my motivation is just for my own pleasure and satisfaction. I enjoy that a lot. You know – you just do what you enjoy.

Thoughts on teachin
GOOD QUOTE
Love of Science
Using ISE - reasons

CHRISTY: When you enjoy the science then you're going to love to do it with the kids.

Yea. And that's the problem as we were talking about earlier, with science education is people are afraid of science. Well, and they don't understand why it happens and they don't take the time to learn. And that's why they love my science lessons

Teaching Science
Curriculum Writing

because I explain it to the kids in the script and they don't have to figure it out. They get the explanation as they teach it.

CHRISTY: And then they gain more confidence hopefully as they do it.

And they say, "Oh, this isn't so hard after all." But in the A book, there's Cameco with the air cookie in a kindergarten curriculum: neon, hydrogen, carbon dioxide – you know showing the various proportions in the cookie pie of the gases in the atmosphere. And I was going, "Oh, shit. These teachers are not going to like this." (both laughing) They're going to think these kids can't do this. It almost has to be modeled for teachers to understand.

Curriculum Writin
Teaching Science

CHRISTY: Not just looking at the content.

Yea. It really scares me.

CHRISTY: Well, once they start selling, you can do workshops.

Yea. Yea. I think we're going to have to. It may be that it won't sell as much until we do. But I really, really, really tried to bring it down to a level that just your ordinary person can be comfortable with and still provide some challenging thought. It's a hard line to stand on. It's real hard.

Curriculum Writir

CHRISTY: To do both of those things and do both of them well.

Because my…just baseline capabilities in terms of what scares me and what doesn't is way higher than a lot of peoples and its real hard for me to drop back. Like I'm going, "What's so scary about helium?" And they'll say, "Well, I can't take that to kindergartners!"

Curriculum Writir
Teaching Science

CHRISTY: Because I have trouble with it, therefore they must!

Yea. Yea. But your three year old could learn about the air cookie. It's so easy and so fun and so right there. Just blow up a balloon. (laughing)

Curriculum Writir
Teaching Science

CHRISTY: Well, it is really fun talking to all my teachers in this study because they are so different but yet every single one of them loves science.

Well, that's good! Are you finding that people are fairly literate and fairly at ease with science?

CHRISTY: Well, you have to understand – the teachers in my study – most of them are at the level you are in their interest in taking field trips. So they are all really into using the community in some way and they are all big on science. And they are all elementary teachers. But let me tell you – it was hard to find them. It was hard to find you.

. I bet.

CHRISTY: Like you said, there's just not a lot of teachers doing science and then going to the next level and seeking outside resources. That's a whole other level. But it's so fun because its so easy for me to talk to people who love science especially because I love science.

I know. Well, that's the bottom line Christy. You're knowledgeable and not afraid and know its beauty.

CHRISTY: Well, and I'm finding that everybody really wants to talk about it because they don't talk about it with other teachers because the other teachers...like one woman told me, "You know, I can' t talk about all this great stuff I've done because all the other teachers think I'm bragging and they don't want to hear it."

Yea. And that's really true. That's really true. It's hard to find a balance in getting people excited about a concept without sounding like you're tooting your own horn.

Science leader~

CHRISTY: And you're lucky in your district to have those teachers at those schools that are doing what you're doing.

I know. And I kept PALS so quiet for so long I just quietly did it. And people would come in and say, "Well, what's this? What are you doing here?" I did not go out and talk about it. I did not. Because people would just look at you like "Well, I'm not going to do all that work!" or "You think you're real special." Kind of deal. I guess it's just a defensive mechanism. It's certainly nothing that I've pushed. And I still – we're going to have 4 new teachers and I'm going to say, "Well, okay, this is something that I do and your welcome to ask me for anything. I'll do anything that I can to help you do any of this. If you want to look at it, that's fine. It's in that file cabinet. If you're interested, I'll work with you on it. If you're not, that's fine." Yea. We're just lucky that people have said, "Hey, yea. Let me see that. This looks good."

Curriculum Writir
Science leader~
Teaching Science

CHRISTY: The interface looks really interesting. It's not intimidating in any way.

. No, it's not. It's not.

CHRISTY: So are they selling it now?

No, they're not finished with it. Kathy just called and said that the owner just called me and said, "We're in in Corpus Christi – Kindergarten Teachers of Texas – have a huge conference. She just got into the conference and they've done 3 books and B is illustrated by a horrible illustrated, it needs to be completely redone. I just said, "Oh my goodness. They left these bad illustrations in." So I have no clue as to when they'll be finished. is just beside herself she is so mad because it was supposed to be out three years ago. Curriculum Writi

CHRISTY: Oh my goodness.

. I know. So I don't know how in the world they can take it to KTOT and say, "Here's a program" and still be a year from being able to send out a product. It just doesn't make any sense to me. So I don't know. It's kind of a scary deal. I'm thinking there going to want us to present at KTOT too. And I don't want them to present and then them say, "Sorry but we don't have anything for you." That just doesn't make good sense, does it? Curriculum Writi

CHRISTY: Okay.

. Is that enough stuff?

CHRISTY: I think so – for today.

(we then begin talking some more and some is relevant....)

. Coral reef biology. I love to dive. I love to dive. That is one of my favorite things in the universe to do. It's just so expensive to get to a coral reef. And the end of my letters, if I'm stressed, I'll say, "Need coral reef." And now my friends know what I mean. At first it was like, "What is this, 'need coral reef' that you always write?" But that to me is heaven – put on my dive gear and just going away. But I love PA – I love . I love . And I love the National Fishery up north. It's just so far to get to South Padre. Port A is a lovely little town and the – I noticed that they're going to be releasing the turtles while we're going to be there. I'm so excited. I'm going to call the U.T. place as soon as I get there. I'm sure they're the ones that are sponsoring it. There was an article in the paper about how they're Love of Science going to be releasing the turtles from the – until the 18th- right when we'll be there. I'm going to make arrangements to go. Watch them. It's funny. We were talking about refueling. If I don't get my day on the beach – one day – that's all it takes – were I do my dawn run. I run the beach. And then pack my bud light in my ice chest and take my chair and ever since my kids have been big enough to handle it on their own, it was like, "Don't bother me. Don't talk to me. Leave me alone." And it takes one day. And I just sit on the beach and listen to the water.

CHRISTY: That sounds so good.

: And only a person who loves the beach can really understand.

CHRISTY: Yes. And I'm still not at the point that I can do that!

You can't. You're husband would have to take the kids.

(We digress and end the interview with scheduling the next one for July 13 at 1:00.)

(end of interview)

Appendix E.2
Interview Summary

Suzanne's Interview Summary
Interviews 1,2,3

Informal Science Trips
Suzanne says that she normally goes on eight field trips a year. She manages this many by doing two in one day. This particular year she has gone to the Children's Museum, the Art Museum, Museum of Science and History, the Wildflower Center, Jonestown Zoo, Reynold's Farm and the landfill. She says that they also have a fifth trip which she calls the "money and stores" trip. They go to local businesses and interview the people who work there.

She said that she has always done a lot of field trips – even when on the east side of Jonestown. The district gave them a lot of money for traveling.

She says she doesn't do the Nature Center anymore because she feels she has many of the same kinds of animals and can teach it better. She used to go there often.

<u>Landfill</u>
Suzanne spent some time talking about the benefits about the landfill trip. She says that she doesn't know of any other teachers that take their kids there. It is part of their recycling unit – Pete the Puzzle Plastic (from her PALS curriculum). She says that landfills are vast and powerful places and they really make an impression on the students and parents alike. They learn about the plastic liners and methane production – and how they can generate electricity from that. Suzanne says that she has been going there for about 8 years. She would also like to take her students to the recycling center and may try and tack that onto the day they do the money and stores trip.

<u>Wildflower Center</u>
Suzanne says that she really enjoyed the training she received at the Wildflower Center and likes having the backpack they gave her that she can use and take her kids back for free. She said that her school paid for six teachers to attend the training last year. She was really impressed by that. She uses some of the materials they give her but not all of it. She says that if you follow the curriculum just they way they give it to you, you'd never get done in 2 hours. It's too long.

Appendix E.2 *(continued)*

Art Museum

Suzanne says that is the only place that she has to really convince them to let her take her kids – because they are so young. But she spends a lot of time preparing them and talking to them about museums, what they are for and how we act in museums. The kids love the huge paintings and sculptures. And the staff really compliments them on their way out.

University/Museum of Science and History

Suzanne schedules the Art Museum trip with the Museum of Science and History and they walk across campus and interview students. They used to stop in the Geology Building and hear a talk by a professor for them – but with so many classes now – they don't have time for this. The kids love this trip and so does she – but comes out with a headache because of the bad acoustics. She also said that they could make the exhibits more kid-friendly. They are all too high and she has to lift the kids up.

Children's Museum

When Suzanne takes her kids there they focus a lot on social studies – they do the Texas history thing upstairs. And then she lets them loose to explore. She does guide them though the weather exhibit so that they understand it. She liked the monarch exhibit and the tree exhibit.

Reynold's Farm

Suzanne knows the owners – Diane Reynold was a principal in Jonestown for years at Casis where she had animals out everywhere. Suzanne loves to take her class there and it ties in well to both social studies and science. She does this trip with the landfill trip.

Discovery Center

She used this all of the time when she was on the east side but they shut down after she went to Georgia Elementary. Suzanne said they had a lot of good hands-on science things – like the weather instruments and the weight chair. Cal Townsend, a physicist who ran it for a while would come out to their school.

Suzanne wishes that they could do more walking trips – but most things are too far from Jemison. She said that at Lake Evans Elementary, they would walk out to a hill behind the school where they could find fossils. They would walk to the dentist's office. She said that they might be able to walk to the sheriff's office here – which is right down the road.

Appendix E.2 *(continued)*

Other informal science resources that Suzanne has drawn on include an entomologist at university (which she tried to take her kids up to see her butterfly house) and a bee keeper (who she brought to the school). Physics Carnival– out of the old Discovery Center – also came out to their school many times. The physics professor even brought out a deer placenta for them to dissect one time which shocked a few parents!

Suzanne believes that in order to feel any community with our planet, we need to feel community with our community first – in our home, neighborhood and city. Study trips are an essential part of this – it helps kid feel connected to their community. She says that these trips have become endangered species in most schools because of the push on reading. And people aren't making the connection that study trips are an incredible way to teach reading. It really gets the kids excited about reading. Suzanne says that if kids feel excited about a topic, then they are much more willing to take risks and they do more comprehensive work. She uses it as a platform.

Suzanne has also made impacts with parents. Many of them have not been to the landfill or Reynold's Farm or the Museum of Science and History. They really get excited and say they want to come back.

Before and After Trips

Suzanne says she shows the kids pictures of the places that she has taken over the years. And even before this, she really prepares them on the content. Like before the Wildflower Center, they had studied dandelions, yuccas and sequoias. She walks them through what they will be doing at the site and gets them to predict what they will see and elaborate on it. And when they get back, they draw pictures, or write sentences (or dictate one). They also do class writing where they write a story about a trip.Suzanne also takes pictures while on the trip and so they sequence those. She said they are always coordinated to what they are doing in the classroom – they have to be anyway according to district rules.

Making Informal Science Trips Happen

Suzanne is the study trip coordinator for the 6 kindergarten teachers at her school – in addition to being one of three team leaders for kindergarten in the district. She says that they are still doing the trips she set up at Lake Evans and probably still use all of her permission notes and everything. Suzanne coordinates the trips for the whole kindergarten at her school and that is a big job. But she really believes that these trips are essential and that the community is so important for the children. She says, “That’s where it’s all happening!” It’s not as easy to go on all of these trips being out in the suburbs – that’s more transportation time and money. She also says that most people don’t want to mess with planning these trips because it’s a lot of trouble. You have to call and return calls to schedule, do permission notes, write out the objectives, make sure you have the money. But she is willing to do it.

Suzanne said that when she first came to Lake Evans, she would quietly ask the parents for transportation money to go on these trips and they would – just her class. She said that once the other teachers found out, they were very positive and simply asked if they could go too. So it was then that everyone started going – and they asked the PTO for the money for buses. She said that for the first few years, she had to write a proposal and present it at a PTO meeting to get approval for the bus money (she thinks that the district paid for one or two bus trips only). She doesn’t have to present at the meetings anymore – they simply have approved the money. They have even paid for a larger and larger percentage of the total bus costs. But now, there are more kindergarten classes and they need 2 big buses which costs more.

Suzanne says that she gets support from parents and her principal for these trips, but the superintendent has not been very supportive of any science projects. Suzanne is worried that she may be the reason why she has heard that they may be limiting her informal science trips. Suzanne says that the superintendent is simply not a science person and doesn’t like all of the science “stuff’ in Suzanne’s room and says it is too cluttered.

Suzanne says that she has “unity” on her side from the other kindergarten teachers. They all want to go on these trips and see the value in them. She said if anyone questioned it or felt pressured to go, then the funding would be cut more easily. But the first and second grade teachers don’t like it that the kindergarten goes on so many trips because the parents expect it the next year. They say they can’t go on any trips because they did them in kindergarten. Suzanne says that she doesn’t understand why they say this because the kids get such different things out of the trips when they go back a few years later.

Suzanne says that a lot of the reason she does these study trips is because she is interested in it and loves it. She says, “You do what you love.”

Appendix E.2 *(continued)*

Teaching/Education Background

Before teaching, Suzanne helped start the day care center a local college for continuing education students. She began teaching kindergarten in 1974 at age 26 after completing her degree in education. She taught at Tracey Elementary in Jonestown and in 1978 received her masters degree. Suzanne says that she then took a 3 year leave of teaching and traveled to Tanzania, Africa where she and her then-husband started a photographic safari company. She then came back to Jonestown and taught in JISD (at Stepan, Georgia, Zuniga and Rogers) until 1989, when she moved out to Lake Evans and taught at Lake Evans Elementary for ten years. Suzanne has been teaching at Jemison Elementary since 1999.

Suzanne was really influenced by her education at the university. Nora Fairchild was her mentor and really encouraged her to go into education.

She didn't have much exposure to science in college – she was focused on reading and language. It wasn't until grad school – where she took Dr. Caldwell's course in science methods, that she had some exposure. He really had a positive influence on her – and actually helped her to get her curriculum published.

Suzanne received her masters degree in Curriculum and Instruction through the Teachers' Corp – which she said was a spin-off of the Peace Corps where people were out to save the world. So there education would be paid for if they agreed to teach in low income areas for a while. She did this while she was teaching and said it was tough.

<u>Teaching as a Profession/ East side of Jonestown</u>
Suzanne said that back when she started teaching in the 1970's, she really lived for school and wanted to save the world. She said that she doesn't see it so much in young teachers anymore. She said she looked at herself as a social worker and a teacher. They would really reach out to families in the community and nurture families in ways that most educators just don't do anymore. They would do home visits, help them get food stamps, medical care and library cards. Suzanne said that they felt responsible for helping them in all aspects of life. She said she doesn't interfere with families as much anymore probably because of the school she is at. She taught on the east side of Jonestown for 11 years where the needs are different. They took more study trips to places like the tortilla factory – but most of the trips are the same ones she takes now. But it was essential then that those kids be taken out into the community. Suzanne said that she really had to

expose the kids to important ideas and catch them up so that they would be ready to learn. Now – its kind of a luxury. She said as a kindergarten teacher in east Jonestown, she got them really "raw" and said that is was a lot more work to get them to read.

Suzanne says that she misses teaching in Jonestown because they had such an innovative, creative kindergarten program and had some real leaders in kindergarten education – such ass Janet Wilson and Sue Kaye. These were her real influences and her first supervisors. Suzanne says that attributes her whole interest in working with the outside community to them. She says that they were big advocates of traveling away from school for the kids – to enhance their learning. She said that while on the east side of Jonestown, they got plenty of money from the district for traveling and they did a lot of it. They had enthusiastic interns from the university who also helped to get the other teachers excited about taking trips.

Suzanne also helped to get the playground built at Tracey Elementary based on Frank Hill's (professor at the university) childhood play and playgrounds. This really required work with the community to get the funding to build it. She said they got a grant and then got parents out to help build it.

Love of Science/Growing Up

Suzanne traces her love of teaching science back to her father who was a research mammalogist. He was worked with deer in Texas. He worked with Fish and Game before going to Meade College and Suzanne remembers going to look for turkeys with him along the river. He also went to Africa to research wildebeests – which is how she ended up going over there later. She spent a month with her parents when they were living on the Serengeti and fell in love with it. So after she got her masters degree she planned on going back over there. She really built up her knowledge while running her photographic safari company. Suzanne said that if she had to do it over again, she would probably go into the biological sciences as a profession. Suzanne said that her dad was always reading anything in science and she was influenced by that – she is the same way today. She said she is now reading the "Field Guide to the Trees and Shrubs of Texas".

Her classroom is full of animals and she regularly does a monarch watch during migration.

Appendix E.2 *(continued)*

Lake Evans ISD

When she came to Lake Evans ISD, there was really no kindergarten curriculum – a district wrote its own and it wasn't very creative. She says that they just recently got a state adopted math book, but they've always had to buy their own science books. She says that it can be frustrating working in smaller districts because they don't often have the kind of leadership of larger districts and the influx of new ideas. When Suzanne first came out to Lake Evans they were doing pretty boring stuff- with not a lot of hands-on science activities. It was all very basic. While in Jonestown, they had been studying monarch migration. Suzanne believes that kindergarteners can learn much more and says that her present curriculum is more demanding – although she did get some initial resistance in Lake Evans about how much the kindergarteners could learn. Suzanne says that the other kindergarten teachers here have really opened up and that they are all supporters of study trips.

Suzanne says that she was really upset when the district decided not to continue membership with the Science and Living Material Center through the Region Service Center. It is 25 cents a year per child for the whole year for the district and teachers can check out all sorts of things. Teachers can get animals, or any other living materials – like algae or plants. The reasoning for cutting the funding for that was that the teachers would not use it. She said that in Jonestown, that was never an issue. It was just always assumed that the district was a member. She really relied on it.

Suzanne says that almost everybody makes more money that she does in Lake Evans. She has lots of mothers who don't work and so she has a lot of help in the classroom. She says that affluence makes such a difference. The kids have most often been to many of the places she takes them. They are "wise in the ways of the community". She says that her focus on study trips has changed from basic things (like when she was in Jonestown) to more content – relating it to more of what they have been studying.

Suzanne's current principal has been very supportive of everything she wants to do and is interested in science. Suzanne is very thankful for her. Her last principal at Jemison was not and was scared of science. Suzanne said that she was frightened of the snake in her room and wouldn't come in there. The parents eventually had her removed.

Appendix E.2 *(continued)*

Teaching Science

Suzanne says that she bases much of what she teaches in her classroom around science. She says that when she first came to Lake Evans, everyone was doing pretty "babyish" lessons for kindergarteners. She really wanted to raise the level of expectation for these kids – which she and other teachers have managed to do over the years. She says that she has a reputation as the science teacher at her school – not many other teachers really integrate that much science into their curriculum. Suzanne says that by basing reading lessons on science, the kids want to learn to read even more because they are so interested in the content. She has been able to teach them words like metamorphosis and echinoderm.

She regularly keeps animals in her classroom. At the time, she had four aquariums going – goldfish, tiger salamanders, hermit crabs and a tarantula. They also raise caterpillars and do a monarch watch. She usually has a snake, hamsters and a guinea pig. She's also had lizards, turtles, rats. She lets teaches check them out so that the whole school can benefit. Suzanne pays for this out of her own pocket – about $2000 a year. The parents seem to be helping her out with this more now.

Suzanne uses the pretend center in her room to extend many of her science lessons. She says that it has been a marine research laboratory – where she puts out a blue pool and fills it with plastic marine animals and salt water. They put on little masks and use poles and microscopes. It's also been a lobster fishing boat. She says the kids just love it and it makes her feel good about teaching. She said if she couldn't do those things, she'd go crazy.

During Interview #1, she was excited because the next day, they were going on their field trip to the Jonestown Zoo and the Wildflower Center. She said it was going to be a "classify animals morning" and a "classify plants afternoon". They have covered almost every type of animal and have exposure to different kinds of plants. They study dandelions, yucca and sequoias specifically in their curriculum as representatives of plants in their curriculululum. Suzanne says that they understand the terms native and xeriscape and have studied water conservation. Her attitude towards teaching science is, "Why wouldn't they be interested in this stuff?" She gave an example of students bringing her caterpillars during Extend-a-Care and they were all really studying them and admiring them. She says they looked in several books trying to identify them.

Suzanne thinks that things will change in regards to peoples' focus on science once the state starts testing in science. (TAAS). Yet, this could not be so good either in that teachers who are more hands-on, like her, will have to focus more on paper and pencil tests. She says that kids need that experience of working with science experiences. She's worried that this could change even the younger grades approach to science.

<u>Kindergarten Curriculum (PALS)</u>
Suzanne – along with another teacher, Mavis Skief- have written a comprehensive kindergarten curriculum that has recently been published by Kamico in Jonestown. She has science-based characters for each letter of the alphabet with corresponding lessons in all areas of the kindergarten curriculum. They do a letter a week. There are 26 books. She said that the study trips she takes and this curriculum evolved hand-in-hand because PALS is based on a need for children to learn to read in a setting – or within a context they are really excited about. And she says that there is nothing more exciting to a child than science – especially biology. Most of the PALS are based on plants or animals – and they are all environmentally based. Suzanne's most ardent hope in working with young children is that she helps to build children who have a little awareness of what is going on in their world. She says that she sometimes drives parents crazy with her emphasis on recycling and environmentally-conscious living.

Suzanne said that she decided to create this curriculum because she and Mavis had been using the Letter People. They decided to substitute the letter people for more exciting, environmentally based characters. They tried to stay in a "backyard" format so that these characters are things that the kids are familiar with – because that is the way they learn best. Suzanne says that the kindergarten teachers at her school have slowly picked it up and that in turn, the kindergarteners are getting more science. She really scripted it for them so that they wouldn't be intimidated by it. And she put it all together for them because its hard for teachers to gather all of these activities and experiments about science together. And she tied it into reading so that it doesn't have to be a discontinuance from the rest of the day.

She says that most teachers don't have any interest in science. She hopes that by making science friendly with her curriculum, that she can help teaches become more comfortable and therefore teach it more.

Projects
Besides writing her kindergarten curriculum and being team leader for kindergarten, Suzanne is also really interested in creating a xeriscape garden at her school. She saw that the National Gardens were giving out grants for building school gardens. Suzanne knows quite a bit about xeriscape gardening and her

Appendix E.2 *(continued)*

principal was very excited about it as well – esp. because they were going to be at a new school. But the superintendent said “No.” – so they had to stop it. She said that she was concerned about maintenance of the garden.

Appendix E.3
Code List Sorted by Frequency Used (for all participants)

1. **Teaching Science**
2. **Thoughts on Teaching/Learning**
   Refers to thoughts on teaching and learning in general but does not necessarily exclude science. This is more of their approach or philosophy on teaching.
3. **Using ISE – Reasons/Thoughts**
   Thoughts and reasons for using informal science – also includes implications for teaching science through informal science…what it means.
4. **Low SES school**
   Refers to the challenges associated with teaching at a low SES school. This also refers to the special problems these students face, as well as family issues. Also includes issues with GT students.
5. **Science Leader**
   Refers to leadership role at the school as a leader in science education. Can also refer to science workshops, initiatives that they have participated in. This is kind of a "lump" category for science-related activities and the perception by others that they are "science" people. This does not necessarily include ALL of the science leadership for a participant – could be listed by itself.
6. **Love of Science**
   Includes their stated appreciation for science but also includes activities, experiences etc. outside of teaching science that point to their interest in science.
7. **Background – Teaching**
   Refers to teaching background before now.
8. **Field Trip/Project Constraints**
   Refers to any hindrances to doing what they want to do with their class. This especially refers to having to "drag others along" and the frustrations. This is also related to their role as science leader.
9. **University Marine Science Institute/ Port Conner**
   Refers to any field trips, workshops or partnerships with this ISE resource – and any thoughts on this.
10. **AAAS Contest with Nature Center**
    This is directly related to NC Project. Several participants were involved in this with the Nature Center.

Appendix E.3 *(continued)*

11. Curriculum Writing

For Suzanne – this especially refers to her own curriculum. For others, it is a variety of projects.

12. Thoughts on Teaching Profession

Refers to both positive and negative comments on profession of teaching. This is related to "love of teaching" but is more about the profession.

13. District Issues/Support

Refers to the level of district support for ISE/teacher ideas, etc. Also refers to anything else mentioned about the role of the district.

14. Principal Support

Refers to varying amounts of principal support – or lack of support. This can also refer to comments about the principal in general.

15. School Change

The positive and negative aspects of the change in school in the last few years. For Greg, he really focuses on the realized need to "really educate" the kids – beyond the TAAS. For Betty, this was the emphasis on literacy and TAAS. Although these two are closely tied.

16. Field Trip Structure

Refers to how they typically structure field trips – i.e. how long, how many.

17. Above and Beyond

Refers to the help they give students and to the school beyond what is required of them. This is related to "professionalism".

18. TAAS

19. Science Fun Day

Refers to all projects done for Science Fun Day.

20. Family's Love of Science/Education

Refers to the value that their family places on science and education, in general. Includes present family and also family growing up. This is related to Background-Growing Up and there may be cross-overs here. Includes value statements and descriptions of experiences.

21. Parent Issues/Support

Refers to the level of parental involvement in field trips. Can also refer to issues or problems in dealing with parents of their students as it relates to using informal science.

22. Making Field Trips Happen

Refers to the great lengths that the teachers will go through to make sure their students are involved in projects and go on field trips.

Appendix E.3 *(continued)*

23. Background – Growing Up

Refers to parents growing up, school background, development of an interest in science. Also linked closely to "love of science".

24. Level of Parental Involvement

Refers to the level of parental involvement at the school in general – not just in terms of informal science.

25. Animal House

Refers to animals either in the classroom or in a separate facility that they maintain. Closely related to "Love of Science" and "Teaching Science".

26. Background – Grad School

27. Background – College

28. Betty's School – Future Changes

Refers to the coming of the alternative school to Westside Elementary and the overall change that has been happening in terms of size and student population. This is different from "school change" in that it does not deal directly with the emphasis on TAAS.

29. Professional Transitions

Refers to upcoming changes in his/her career. These are current – past transitions would fall under "Background – Teaching"

30. NASA Project

Refers to Kathryn's involvement in the astronomy project. She was one of the first elementary teachers to fly in this flying telescope and then spoke on behalf of NASA to get more federal funding to build a new flying laboratory.

31. Using School Habitats

32. Nature Center – Reasons

Refers to reasons for using the Nature Center.

33. School Demographics – Thoughts

This code is closely linked to low SES school and those quotations for "low SES" might need to be look through. It's also closely linked to "level of parental involvement" and "ISE: Parent Support". All of the teachers talked about how this influenced their teaching and their approach to using informal science.

34. Tech in Classroom – Thoughts

Mainly refers to Joe's experiences with technology.

35. Garza Young Scientists – Collaboration

Comments about the collaboration involved in forming GYS and maintaining it. Also includes comments about collaborating with outside resources on aspects of their work with the Nature Center (i.e. web site production)

36. Other Field Trips

Refers to places that were briefly mentioned.

37. "Missionary Work"

Betty actually used this word to describe her (and other teachers') approach to teaching their more "at-risk" students.

38. Multi-age

Refers to the multiage program in Kathryn's district and the issues surrounding that.

39. Summer/Part-Time Work

Refers to jobs taken outside of teaching for extra income.

40. After School Projects

Refers to activities/projects that the teachers led after school. This can also refers to thoughts about it in general. If they talked about it at length – like Greg's AAAS competition or Joe's pond study or Science Fun Day projects – then they are under different codes. Many of the projects these teachers do require after school hours.

41. Garza Young Scientists – Magnet School

Issues involved with getting students into the magnet school successfully. This is closely linked to "GYS – Collaboration".

42. Background – Jobs Before/In between Teaching

This can also refer to being a work-at-home mom.

43. Discovery Center

Associated with the Children's Museum.

44. Family ISE

Refers to trips to museums, etc. with family (NOT growing up).

45. Wildflower Center

46. GOOD QUOTE

These are noticeably good quotes that would be good examples in the findings section.

47. Garza Young Scientists – Beginnings

48. Garza Young Scientists – Goals

Goals of the GYS program and the program in general.

49. Jonestown ISD – Missing it Now

Mainly refers to Suzanne

50. Garza Young Scientists – Funding

How the GYS program is funded. This includes info on the Nature Center.

Appendix E.3 *(continued)*

51. Earth Wise Camp
Refers to the program through the City of Jonestown – Westside Elementary was involved with this.

52. Teaching – First Years
Mainly for Greg

53. Garza Young Scientists – How It Works
Basic workings of the program.

54. Nature Center Project – Contour Map
Refers to Greg's descriptions of this specific project. He spent a lot of time on this.

55. Love of Teaching "I got the fire"
Refers to any description of their desire to teach and how they came into teaching.

56. Project World
Refers to Kathryn's Project she is starting at her school.

57. Sea World

58. AAAS Project with NC (general)
Refers to working with the NC on the AAAS project in general. This does NOT refer to Greg's discussions – his are more specific. This is more for Betty and Joe.

59. Nature Center – Aquifer Exhibit
More specifically for Betty.

60. New School
Recent transition to a new school (Vicki and Joe)

61. Dragging People Along
Closely related to "Field Trip/Project Constraints"

62. Children's Museum – Problems
Refers to Vicki's problems with the museum – mostly over payment for work and respect.

63. Green Way Class
House across the street from Westside Elementary funded through JISD.

64. Invent Jonestown Club

65. Personal Illness/ Crisis
Refers to how personal illness or crisis affects what they do as teachers.

66. Landfill Trip
Refers to Suzanne's trips.

67. Mystery Project
Refers to this project that Betty was involved in.

Appendix E.3 *(continued)*

68. Space Curriculum

Refers to curriculum that Joe is working on in partnership with university.

69. Ocean Science Project

Refers to Kathryn's involvement in this project to get scientists and educators working together. This is directly related to "Science Leader", "NASA Project" and "Geosciences Project".

70. Fifth Grade Experience Trip

Joe's descriptions of this.

71. Pre and Post Field Trips

Refers to what the teachers does with the class before and after field trips. I started this code with Suzanne but there are likely more examples under "Using ISE" – since there is so much lumped in there.

72. What is Science?

This refers to the nature of science. School science vs. science. And what the teachers sees as true science.

73. Port Conner Aquarium

74. Hispanic Community Issues

More specifically for Greg's thoughts on working in the Hispanic community.

75. Nature Center Activities

Specifically for Greg's class activities while at the Nature Center.

76. Tech in the Classroom – Projects

NOT general thought on technology in the classroom

77. M.A.R.E. Project

Marine education curriculum.

78. Nature Center – Time

How much time Greg's class spends at the Nature Center.

79. University Telescope Visit

Refers specifically to Vicki's class trip to the university.

80. Teaching Constraints

Refers to the more annoying aspects of the practice of teaching.

81. Nutrition School Project

Refers to specifically to the program at Greg's school. Related to "Hispanic Community Issues", "School Change" and "Science Leader".

82. Reading and/or Math Emphasis

Refers to the emphasis on reading – related to their pursuit of graduate degrees and/or professional organizations.

Appendix E.3 *(continued)*

83. Astronomy Curriculum Projects
Specifically refers to Joes' projects. These all involve the use of technology so could be closely related to "Tech in the Classroom – Projects".

84. Community Support
More specifically for Greg's program.

85. Inspirations
Refers to people who have really inspired them to the point that they say so. Having a father who is a scientist isn't enough for this code.

86. Nature Center Project – Water Quality
Specifically refers to Greg's work with the Nature Center.

87. Public Education Problems
Refers to Greg's comments on education in general.

88. Model School
Related to "School Change" and "TAAS". This refers to Greg's school serving as a topic of research on how to get TAAS scores up.

89. Garza Young Scientists – Mentoring
The relationship that was set up through the university when GYS first started.

90. Garza Young Scientists – Macroinvertebrates
This refers to the 2000-2001 project. It is part of the initial Nature Center project on Fauna – just expanded upon.

91. College Level Teaching
Refers to Kathryn's teaching of a science methods course and her thoughts on it.

92. Ivans Caverns

93. Serendipity
Joe's comments on this. He used that word.

94. Reynolds' Farm

95. Blue Ribbon School
Refers to the recognition that Kathryn's school received for nomination for this honor – and the process of getting there.

96. Electronic Field Trips
Refers to technology-based field trips – mainly sponsored by Parks and Wildlife.

97. Walking Trips
Trips within walking distance of school.

98. William's Farm

Appendix E.3 *(continued)*

99. City of Jonestown Water Department Project

100. Nature Center – Helping Them Too
Refers to Greg's partnership with the Nature Center – what the students are doing to give back to the Nature Center.

101. University Teach Program
Refers to a program where students from the university (in the sciences) came to their school to mentor and teach students in science.

102. Geosciences Program
Refers to Kathryn's involvement in coordinating the geoscientists with education. This is directly related to "Science Leader."

103. Nature Center Project: Fauna
Refers to Greg's program.

104. Nature Center Project: New Group Transition
(Greg's program) Refers to the changes associated with bringing a new group of students into the program and how the fact it is a fifth-sixth grade program now has changed things.

105. University Entolomogist

106. Religion

Appendix E.4
Emergent Themes with Comments

- **Love of Science**
  - This was a dominant code and present for all teachers. It was apparent in their descriptions and from my observations. Yet the men seemed to "assume" that they would have an interest in science and did not reflect on it as much as the women.
- **Science Leaders**
  - All teachers were involved in leadership activities. See this code and more specific ones for each teacher for support. Also see resumes.
- **Active vs. Appreciative**
  - I'm not sure how to describe this – but it is my perception that some of the teachers are more active participants in their use of informal science than others. They are more involved in the planning and make sure that they are in control of what is going on. I would say this applies to Kathryn, Suzanne and Greg especially. Vicki and Betty are more passive in their use and I'm not sure where to put Joe yet.
- **Family Interest in Science**
  - All of the teachers seem to have had strong family influences in their interest in science – from parents, aunts, uncles, grandparents. Vicki reflects more on the presence of it now while the rest mention it more in terms of when they were growing up.
- **Approach to Science Teaching**
  - A major code was "Science Teaching". They talked a lot about it. They all seemed to describe an inquiry-based approach. Joe and Kathryn more specifically referred to constructivist teaching/learning but not the others. They all have a "science focus" in their teaching – significant for an elementary teacher.
- **How They Use Informal Science – What They Think Is Important**
  - Kathryn uses it more as a resource in teaching – she emphasized that. She especially discussed the Nature Center in that way and specifically mentions the importance of science content people to her.
  - Betty seems to place great value on informal science for its inherent qualities. She really "loves" museums

    - Greg used the word "laboratory" and that seems to sum up his approach to wanting to work on individual projects and he values the resource of the "site".
    - Suzanne uses many informal science sites and focuses on field trips – many of them.
    - Vicki is the natural "negative case" , I think. She says she learned how to teach through using informal science. She doesn't use it as much as other teachers now.
    - Joe really likes to partner with informal science sites in the community to work on interesting projects. He's not much for the traditional field trip.
- **Advanced Degrees**
    - Four of the six teachers have masters degrees. These are also the teachers I see as "extremely committed" to using informal science (Joe, Kathryn, Suzanne, Greg)
- **Dragging Other Along**
    - Joe and Suzanne especially talked about how having to work with people who really don't want to go the extra mile to make something work can be draining. Vicki also talked about this to an extent. This is especially true in after school projects and field trips. See the codes "Above and Beyond" and "Field Trip Constraints" too The code "Dragging People Along" wasn't initiated until Vicki – so may need to go back through these other codes for support.
- **Parental Involvement**
    - The SES level of the school and the level of parent involvement is a recurring influence on how these teachers use informal science. Parents are an important factor. See "ISE: Parental Support" and "Level of Parental Involvement" and "Low SES School" and "Blue Ribbon School" for support. Also – "New School", "School Change" and "School Demographics". This also seems to influence the kinds of trips they take.
- **District Issues**
    - The district was a big influence for Suzanne and Kathryn mainly – those in smaller districts.
- **Principal Support**
    - Principals impacted several teachers more than others – Betty mostly. She spent a lot time discussing this.

- **How vs. Why**
    - Some teachers tended to focus on the “why” of the question and others on the “why”. Greg and Joe – “how” and all of the women – “why” (except Suzanne also talked a lot about “how”). Is this a gender thing?
- **Science as a Hook**
    - Several teachers described science as being a hook into learning. Greg actually said “hook” and Joe said “handle”. See Suzanne too on how all kids like science and she uses it to get them to want to read. The rest of the teachers all talk about how they base their teaching on science. See “Science Teaching” for this.
- **Missionaries**
    - Betty and Greg both specifically refer their work as “missionary” work. Greg also cites an article in the paper he wrote about how the most effective teachers of minority students go way beyond their regular job duties and get involved in the students’ lives. Suzanne also talked about being a “social worker” when she worked at poorer schools in Jonestown.
- **Pam: Bridging with Scientists**
    - I see Pam having a strong tendency to bring the language of scientists to her students. She works with scientists in many ways – geosciences, astronomy, Project World. She is aware that she is good at communicating the science to her students. She knows her resources well and relies on them. This can also be seen in her approach to teaching science methods course where the emphasis is on “knowing how to find out” and not “knowing the answer”.
- **Pam: Making it a Profession**
    - Much of what Pam has done with her career has shown how she has really worked to make it satisfying and challenging for her and her students. It goes back to her childhood when she saw how her father did not respect teaching – and she saw plenty of teachers who didn’t make it a profession – just a job. She didn’t want to be like that. See “Science Leadership” too.
- **Curriculum Fit**
    - The teachers vary on how much emphasis they give to how a trip fits into the curriculum – although they can all make the connections. Kathryn may be at one end and Vicki at the other.

Appendix E.4 *(continued)*

- **Own Family Support**
    - Although this is not a code, many of the teachers refer to the support they receive from their spouses, close friends, children or their parents in terms of their use of informal science. Kathryn and Betty especially reflect on this. Greg never talks about his family and neither does Joe.
- **Keeping Head Low**
    - Kathryn and Suzanne especially talk about this – they feel they can't talk about their passions or accomplishments. It was obvious how eager they were to tell me about their accomplishments (someone who would listen and appreciate?).
- **Making It Happen**
    - Teachers at low income schools have different issues to deal with in planning field trips. Money and getting parents to chaperone are big issues. See "Field Trip Constraints" for more support. Betty, Suzanne and Greg seemed to focus on this more than the others.
- **Vicki: Museum Work Gave Her Exposure**
    - Working at the Children's Museum in the summers gave Vicki exposure to a multitude of informal science sites in the area.

Appendix F
Member Checking Procedures

Initial member checking was done during interviews by asking questions for clarification and expansion such as, "So,….(restatement of what he/she said)…is that right?" or "Could you tell me more about that?" Many times, I simply restated what I heard them say in a question. They would either respond with a "yes" or clarify what they meant. Examples of this can be seen in Appendixes D.1 and E.1.

Follow up member checks were done through email with the use of summaries for them to review and any additional questions. Examples of these messages are on the following page. An example of a summary is included in Appendix E.2. Final member checks were done by sending the participants relevant sections of the final study report for them to review. My email message to the participants concerning the final member check follows, as well.

christy youker

From: christy youker <cyouker@mail.utexas.edu>
To:
Sent: Wednesday, January 16, 2002 4:16 PM
Attach: Int. 3,4,5 Summary.doc
Subject: Re: Grant money?

I really just need for you to look over this interview summary. If you find anything that needs clarifying or correcting, just let me know. Otherwise, you can give me an official "okay". I'll be sending you sections relevant to you once I finish them for you to do a final check.I'm finishing up a "case by case" chapter on the 6 teacher participants of the study now. And I'll start working on the "cross case analysis" chapter next week. It's looking pretty good!
Thanks again!!
Christy
ps... if you'd rather have a hard copy let me know! I'll be glad to send you one.

---

christy youker

From:
To: <cyouker@mail.utexas.edu>
Sent: Wednesday, March 27, 2002 8:54 PM
Subject: Re: Re: Schoolyard Habitats

Christy, Congratulations on graduating! Your summary looks fine and dandy. It has my OK. Whenever you want to meet is fine....of course, June is best!

---

christy youker

From: christy youker <cyouker@mail.utexas.edu>
To:

Sent: Wednesday, May 29, 2002 9:29 AM
Subject: Finally finished!

To the wonderful teacher participants of this study of teachers who use informal science.............

I'm finally finishing this dissertation thing! My defense is July 19 and I'll officially graduate this summer. Unbelievable. I need for you to do one more thing. I need for you to review relevant sections to make sure that it matches "your perceptions". This needs to be done before I put it into final form - so we can set a deadline of July 19. I can send it out to you soon....**I just need an address for you. So please email that back to me.**

Thanks for everything,
Christy

Bibliography

Ashton, P.T., and Webb, R.B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement.* New York: Longman.

Bitgood, S.B., Serrrell, B., and Thompson, D. (1994). The impact of informal science education on visitors to museums. In V. Crane, H. Nicholson, M.Chen, and S. Bitgood (Eds.), *Informal science learning: What the research says about television, science museums, and community-based projects* (pp. 61-106). Dedham, Mass: Research Communications.

Creswell, J.W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage Publications.

Cruickshank, D.R. (2000). What makes teachers good? *Mid-Western Educational Researcher. 13*(1), 2-6.

Duckworth, E. (1990). Museum visitors and the development of understanding. *Journal of Museum Education, 15*(1), 4-6.

Erlandson, D.A., Harris, E.L., Skipper, B.L. and Allen, S.D. (1993). *Doing naturalistic inquiry: A guide to methods*. Newberry Park, CA: SAGE Publications.

Ely, M., Anzul, M., Friedman, T., Garner, D., and Steinmetz, A.M. (1991). *Doing qualitative research: Circles within circles*. New York: The Falmer Press.

Exploratorium. (2001, October 16). *$11 Million grant funds new international center to improve science education*. Retrieved May 2, 2002, from http://www.exploratorium.edu/pr/cils.html

Falk, J.H. (2001). Free-choice science learning: Framing the discussion. In J.H. Falk (Ed.), *Free-choice science education: How we learn science outside of school* (pp. 3-20). New York, NY: Teachers College Press.

Falk, J.H. and Dierking, L.D. (1992). *The museum experience.* Washington, D.C.: Walesback Books.

Falk, J.H., Koran , J.J. Jr. and Dierking, L.D. (1986). The things of science: Assessing the learning potential of museums. *Science Education, 70*(5), 503-508.

Fido, H.S.A. and Gayford, C.G. (1982). Field work and the biology teacher: A survey in secondary schools in England and Wales. *Journal of Biological Education, 16*(1), 27-34.

Goodson, I.F. (1992). Sponsoring the teacher's voice: Teachers' lives and teacher development. In A. Hargreaves and M.G. Fullan (Eds.), *Understanding Teacher Development* (pp. 110-121). New York, NY: Teachers College Press.

Gottfried, J.L. (1980). Do children learn on field trips? *Curator, 23* (3), 165-174.

Griffin, J. and Symington, D. (1997). Moving from task-oriented to learning-oriented strategies on school excursions to museums. *Science Education, 81*(6), 763-780.

Haney, J.J., and Lumpe, A.T. (1995). A teacher professional development framework guided by reform policies, teachers' needs and research. *Journal of Science Teacher Education, 6*(4), 187-196.

Hein, G.E. (1998). *Learning in the museum*. London: Routledge.

Hein, G.E., and Alexander, M. (1998). *Museums: Places of learning*. Washington, DC: American Association of Museums.

Hirzy, E.C. (Ed.). (1996). *True needs, true partners: Museums and schools transforming education*. Washington, D.C.: Institute of Human Services.

Horizon Research, Inc. (2001a). *Report of the 2000 national survey of science and mathematics education*. Retrieved March 21, 2002 from http://www.2000survey.horizon-research.com

Horizon Research, Inc. (2001b). *The presidential award for excellence in mathematics and science teaching: Results from the 2000 national survey of science and mathematics education.* Retrieved March 21, 2002 from http://www.2000survey.horizon-research.com

Inverness Research Associates. (1990). *First hand learning: Teacher education in science museums* (Vol. 1: findings and recommendations). Washington, DC: Association of Science Technology Centers.

Inverness Research Associates. (1995). *An invisible infrastructure: Institutions of informal science education* Washington, D (Vol. 1: Findings from a national survey of institutions of informal science education). Washington, DC: Association of Science Technology Centers.

Kaspar, M. J. (1998). *Factors affecting elementary principals' and teachers' decisions to support outdoor field trips.* Doctoral dissertation, University of Texas at Austin.

Katz, P. (Ed.). (2001). *Community connections for science education: Vol. 2. History and theory you can use*. Arlington, VA: NSTA Press.

Kelly, J. (2000). Rethinking the elementary science methods course: a case for content, pedagogy, and informal science education. *International Journal of Science Education, 22*(7), 755-777.

Klevans, M. (1990). *An evaluation of an interactive computer exhibit in a museum setting*. Doctoral dissertation, University of Texas at Austin.

Kluger-Bell, B. (1999). Recognizing inquiry: Comparing three hands-on teaching techniques. In National Science Foundation, *Inquiry: Thoughts, views, and strategies for the K-5 classroom* (Foundations Vol. 2, NSF Publication No. 99-148, pp. 39-50). Arlington, VA: National Science Foundation.

Koran, J.J., Morrison, L., Lehman, J., Koran, M.L., and Gandara, L. (1984). Attention and curiosity in museums. *Journal of Research in Science Teaching, 21*(4), 357-363.

Kubota, C.A., and Olstad, R.G. (1991). Effects of novelty-reducing preparation on exploratory behaviour and cognitive learning in a science museum setting. *Journal of Research in Science Teaching, 28*(3), 225-234.

Lebeau, R.B., Gyamfi, P., Wizevich, K., and Koster, E.H. (2001). Supporting and documenting choice in free-choice science learning environments. In J.H. Falk (Ed.), *Free-choice science education: How we learn science outside of school* (pp. 133-148). New York, NY: Teachers College Press.

Lessow, B.D. (1990). Factors related to elementary teachers' effective utilization of field trips to informal science resources. *Dissertation Abstracts International*. (UMI No. 9119445).

Lincoln, Y.S., and Guba, E.G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications.

Manning, K. (1997). Authenticity in constructivist inquiry: Methodological considerations without prescription. *Qualitative Inquiry, 3*(1), 93-115.

Martinello, M.L., and Gonzalez, M. (1987). The university gallery as a field setting for teacher education. *Journal of Museum Education*, *12*(3), 16-19.

Melber, L.M., and Abraham, L.M. (1999). Linking formal and informal education: A theme issue on museum education [Special issue]. *Science Activities: Classroom Projects and Curriculum Activities*, *36*(1).

Middlebrooks, S. (1999). *Preparing tomorrow's teachers: Preservice partnerships between science museums and colleges*. Washington, D.C.: Association of Science-Technology Centers Incorporated.

Michie, M. (1998). Factors influencing secondary science teachers to organize and conduct field trips. *Australian Science Teachers Journal, 44*(4), 43-50.

Mullins, J.A. (1998). How field trips in natural areas associated with museums, arboreta, and aquaria impact the educational experiences of teachers and students. *Dissertation Abstracts International* (UMI No. 9840837).

Munley, M.E. (1991). New partnerships with schools. *The Journal of Museum Education, 16*(3), 14.

Museum Learning Collaborative (n.d.) *Museum learning collaborative.* Retrieved November 14, 2001 from http://mlc.pitt.edu.

National Center for Education Statistics. (2000). *National assessment of educational progress (NAEP)*. Retrieved May 7, 2002, from http://nces.ed.gov/nationsreportcard/

National Commission on Mathematics and Science Teaching for the 21st Century. (2000, September). *Before It's Too Late*. Jessup, MD: Education Publications Center, U.S. Department of Education.

National Science Foundation. (1997). *The challenge and promise of K-8 science education reform* (Foundations Vol. 1, NSF Publication No. 97-76). Arlington, VA: National Science Foundation.

National Science Foundation. (1999a). *Inquiry: Thoughts, views, and strategies for the K-5 classroom* (Foundations Vol. 2, NSF Publication No. 99-148). Arlington, VA: National Science Foundation.

National Science Foundation. (1999b). *Program announcement and guidelines: Division of elementary, secondary, and informal education* (NSF Publication No. 99-92). Arlington, VA: National Science Foundation.

National Science Teachers' Association. (1996). *NSTA advisory board panels*. Retrieved April 30, 2000, from http://www.nsta.org/about/abps.asp

National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press.

National Research Council. (1998). *Every child a scientist: Achieving scientific literacy for all.* Washington, DC: National Academy Press.

NSTA Informal Science Advisory Board. (1998). An NSTA position statement: Informal science education. *Science and Children, (35)*8, 30-31.

Orion, N. (1993). A model for the development and implementation of field trips as an integral part of the science curriculum. *School Science and Mathematics. 93*(6), 325-331.

Patton, M.Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage Publications.

Pedersen, J.E. and McCurdy, D.W. (1992). The effects of hands-on, minds-on teaching experiences on attitudes of preservice elementary teachers. *Science Education*, *76*(2), 141-146.

Price, S. and Hein, G.E. (1991). More than a field trip: Science programmes for elementary school groups at museums. *International Journal of Science Education, 13*(5), 505-519.

Qualter, A. (1999). How did you get to be a good primary science teacher? *Westminister Studies in Education, 22*, 75-86.

Ramey-Gassert, L. (1997). Learning science beyond the classroom. *The Elementary School Journal, 97*(4), 433-450.

Ramey-Gassert, L., Shroyer, M.G., and Staver, J.R. (1996). A qualitative study of factors influencing science teaching self-efficacy of elementary teachers. *Science Education, 80*(3), 283-315.

Ramey-Gassert, L., Walberg, H.J., III, and Walberg, H.J. (1994). Museums as science learning environments: Reexamining connections. *Science Education*, *78*(4), 345-363.

Resnick, L.B. (1987). The 1987 Presidential Address: Learning in and out of school. *Educational Researcher, 16*(9), 13-19.

Robertson, W.C. (2001). *Community connections for science education: Vol. 1. Building successful partnerships*. Arlington, VA: NSTA Press.

Rodwell, M.K., and Byers, K.V. (1997). Auditing constructivist inquiry: Perspectives of two stakeholders. *Qualitative Inquiry*, *3*(1), 116-134.

Rosser, S.V. (1989). Teaching techniques to attract women to science: Applications of feminist theories and methodologies. *Women's Studies International Forum, 12,* 363-377.

Russell, R.L. (1996). The roles of science museums in schools. *The Informal Science Review,* (no. 19), 8-13.

Russell, R.L. (1997). Science museums and education reform. *The Common Denominator*, The Eisenhower Consortium for Mathematics and Science Education @ SERVE, 2(1), 2-5.

Schoeneberger, M., and Russell, T. (1986). Elementary science as a little added frill: A report of two case studies. *Science Education*, *70*, 519-538.

Schwandt, T.A. (1997). *Qualitative inquiry: A dictionary of terms*. Thousand Oaks, CA: Sage Publications.

Schwandt, T.A. (1998). Constructivist, interpretivist approaches to human inquiry. In N.K. Denzin and Y.S. Lincoln (Eds.), *The landscape of qualitative research: Theories and issues* (pp. 221-259). Thousand Oaks, CA: Sage Publications.

Science Learning Network, (n.d.) *Science learning network.* Retrieved June 26, 2001 from http://www.sln.org/info/index.html.

Science Teachers' Association of Texas. (n.d.). *Board affiliate representatives of STAT*. Retrieved April 30, 2000 from http://www.statweb.org/statreps.html.

Sheppard, B. (Ed.). (1993). *Building museum and school partnerships*. Washington, D.C.: American Association of Museums.

Shrigley, R.L. (1974). The correlation of science attitude and science knowledge of preservice elementary teachers. *Science Education, 58*(2), 143-151.

Smylie, M.A. (1990). Teacher efficacy at work. In P. Reyes (Ed.), *Teachers and their workplace: Commitment, performance, and productivity* (pp. 48-66). Newbury Park, CA: Sage Publications.

St. John, M. (1999). End paper: The value of knowing what you do not know. In National Science Foundation, *Inquiry: Thoughts, views, and strategies for the K-5 classroom* (Foundations Vol. 2, NSF Publication No. 99-148, pp. 109-111). Arlington, VA: National Science Foundation.

Stec, G. (1993). The teacher as partner. In B. Sheppard (Ed.), *Building museum and school partnerships* (pp. 23-31). Washington, D.C.: American Association of Museums.

Storksdieck, M. (2001, July/August). *How teachers handle field trips.* Paper presented at the Visitor Studies Conference, Orlando, FL.

Stronck, D.R. (1983). The comparative effects of different museum tours on children's attitudes and learning. *Journal of Research in Science Teaching, 20*(4), 283-290.

Talsma, V.L. (1996, April). *Science autobiographies: What do they tell us about preservice elementary teachers' attitudes towards science and science teaching?* Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, St. Louis, MO.

Texas Statewide Systemic Initiative. (1999, February). *Science in Texas elementary schools: A report on the Texas poll* (Issue Brief No. 4). Austin, TX: Texas Statewide Systemic Initiative, The Charles A. Dana Center, University of Texas at Austin.

Tilgner, P.J. (1990). Avoiding science in the elementary school. *Science Education, 74*, 421-431.

The Franklin Institute Science Museum. (1992). *Science museums and school change: Making the connection*. Philadelphia, PA: The Franklin Institute Science Museum.

Tressel, G. (2001). Introduction: The symbiosis of formal and informal education. In Katz, P. (Ed.), *Community connections for science education: Vol. 2. History and theory you can use.* Arlington, VA: NSTA Press.

Wellington, J. (1990). Formal and informal learning in science: The role of the interactive science centers. *Physics Education, 25*(5), 247-252.

Westerback, M.E. (1982). Studies on attitude toward teaching science and anxiety about teaching science in preservice elementary teachers. *Journal of Research in Science Teaching, 19*(7), 603-616.

Wright, E.L. (1980). Analysis of the effect of a museum experience on the biology achievement of sixth-graders. *Journal of Research in Science Teaching, 17*(2), 99-104.

Young, B.J., and Kellogg, T. (1993). Science attitudes and preparation of preservice elementary teachers. *Science Education, 77*(3), 279-291.

Youker, C. (1999). *A naturalistic study of two teachers who continually use an informal education site*. Unpublished manuscript.

Vita

Christian Rene Youker was born in Austin, Texas on January 23, 1971, the daughter of Marsha and Rob Youker. After finishing her work at Harlingen High School in Harlingen, Texas, in 1989, she entered Austin College in Sherman, Texas where she earned the degree of Bachelor of Arts in 1993. During the summer of 1993, she attended the University of Texas at San Antonio. She earned her Master of Science degree in Zoology from the University of Oklahoma in 1995. During the following years, she worked as a museum educator at the San Antonio Children's Museum and as a manager for a city-wide non-profit after school program. She entered the Graduate School of The University of Texas at Austin in 1997 and worked as both a teaching assistant in the Department of Biology and as a research assistant at the Charles A. Dana Center, The University of Texas at Austin.

Permanent Address: 5611 Vanderbilt, Dallas, Texas, 75206

This dissertation was typed by the author.